# THE BRITISH VETERINARY JOURNAL

*EDITORS:*
J. McCUNN, *M.R.C.V.S., M.R.C.S., L.R.C.P.*
R. LOVELL, *D.Sc., Ph.D., M.R.C.V.S., D.V.S.M.*
SIR THOMAS DALLING, *M.A., D.Sc., F.R.C.V.S., F.R.S.E.*

**Vol. 109** **November, 1953** **No. 11**

## *EDITORIAL*

### THOUGHTS ON THE WORLD CONFERENCE ON MEDICAL EDUCATION

In August, 1953, the First World Conference on Medical Education was held in London.

It was attended by members from many parts of the world. Papers were presented by authors from thirty-two countries, and the proceedings extended over five days.

The matters discussed were of great importance and aroused such interest that, had it been possible, there was enough fuel to have kept the fires of controversy burning vigorously for many months.

The main theme of the conference was orientated around the education of the undergraduate, the preliminary educational requirements for entry into a medical school, the curriculum, and the methods employed to prepare the student so that he could meet adequately all the diverse commitments of his chosen career. All the factors which came under review apply with equal emphasis to the veterinary sphere, and those responsible for the selection and instruction of the embryo veterinary surgeon can find much food for thought if they peruse the reports of the proceedings. The fount of medical and veterinary scientific knowledge is for ever filling and in recent years the flow has become a torrent, for new discoveries have burst upon us with such impetus that it is almost impossible to keep abreast of the progress of events and a man can be easily outdated in a few years.

*(The October issue of "The British Veterinary Journal" was published on October 1).*

XUM

As new knowledge has become available, and bearing in mind the limits of human effort and comprehension, it becomes necessary that some of the material of pristine importance should be cast aside or be suitably attenuated, otherwise the fountain would overflow with dire effect upon the undergraduates and upon the profession they aspire to adorn.

A veterinary or medical school exists primarily for the purpose of producing men and women reasonably capable of rendering competent service to those who seek their vocational aid. In recent years much emphasis has been placed by those in authority on research and they have demanded that the staff of the schools should devote much of their time and effort to this admirable object, with almost the same degree of intensity as could be expected were they employed in an institution devoted entirely to research activity. Those who propound this idea—and there is much substance in their declamation—argue that no man or woman can be an inspiring teacher unless he or she is engaged in some research activity.

There are dangers in a too rigid application of this hypothesis, for all men are not alike and different spheres of endeavour call for and attract a different type of mentality. A good teacher may be a good research worker, but the converse is not necessarily the case. Frequently the man whose interest is centred primarily in research is a poor teacher and instead of being a source of inspiration to his pupils he talks above their heads and is inclined to induce somnolence rather than alertness when he takes his stand on the lecture-room dais.

A research worker who becomes immersed in or obsessed with his own particular line or sphere of work may lose the ability to take stock of the whole.

There have been instances of men who held "teaching" appointments but were so out of contact with everyday events and their surroundings and with the requirements of the pupils that they were unknown by name and sometimes by sight to the students and even to some members of the staff.

Whatever may be our individual opinions on the course of study to be followed, and it is healthy that we do not all think alike, there are several basically important factors which should be borne in mind by those who are responsible for the selection and instruction of undergraduates.

In making a selection the most vital factor is that the candidate should demonstrate some degree of vocational urge to become a veterinary surgeon; academic brilliance alone does not suffice.

In teaching students the instructor should try to put his remarks in the simplest form, and to do this it is best to presume that the audience knows little or nothing of the subject under discussion. As regards the finished product, the aim should be to send forth a man or woman who is competent to do all the ordinary things which a veterinary surgeon may be called upon to do in the day-to-day course of his practice.

If we follow these basic precepts then we can rest assured that our graduates will be capable of pursuing any line of veterinary endeavour and with credit.

XUM

# *GENERAL ARTICLES*

## THE POSSIBLE OCCURRENCE OF CEREBROSPINAL NEMATODIASIS IN GOATS IN INDIA

By J. R. M. INNES,* Sc.D.(Cantab.), Ph.D., M.R.C.V.S.

Most essential facts concerning the nature and cause of the nervous disease —cerebrospinal nematodiasis—have been laid bare. The history of the events, in the English language, leading to this has been unfolded in papers by Innes (1951); Shoho (1951); Innes, Shoho, and Pillai (1952); Innes and Shoho (1952); and Ishii *et al.* (1953), in so far as the disease in goats, sheep, and horses has been observed in Japan, Korea, and Ceylon. Tribute to original work by Japanese has been made, and some of the knotted threads of this fascinating problem, with its possible implications, have been partly unravelled by the above-mentioned presentations. There are still manifest gaps in present knowledge which may be clarified by further meticulous studies in helminthology and entomology (i.e., relating to the causal worms, *Setaria,* and their intermediate hosts and their life history). Pathology must still remain the keystone in further studies of the disease, merely because it stands as the unequivocal method of diagnosis. There is no immediate escape from that possibly arduous task. Reliance solely upon the history, the seasonal incidence, and the clinical signs of individual cases as diagnostic indices might be misleading. The present requisite is to define the problem of the natural disease more precisely. In the first instance it is necessary to determine the geographical distribution and annual incidence in animals (and perhaps man) of nervous disease caused by nematodes. Shoho (1952) has indicated a possible approach to chemotherapeutic control by using diethylcarbamyl-4-methylpiperazine (Lederle).

Cerebrospinal nematodiasis is a seasonal, acute or subacute, paralytic disorder resultant upon insect-borne transmission of nematode larvæ (*Setaria digitata*) to some domestic animals. Subsequently the larvæ develop and wander from the subcutaneous inoculation sites to emerge as young worms into the nervous system. Varied grades of clinical neurological disorder can be expected, dependent on their anatomical lodgment, their period of stay, or their further wandering in and from the brain or cord. These may range, in goats, sheep, or horses, from clinically silent cases to those with mild nervous signs which resolve, or to others with acute limb paralysis and a fatal termination. The classical lesions have been described and illustrated previously. Pathologically the disease is a discrete focal form of encephalomalacia, or spinal malacia, varying in location and volume of tissue distruction, and in its concomitant inflammatory and glial reaction. There are other features depicted in this pathological process which make it somewhat unique and easily identified.

*Present address:—Chief of Pathology Branch Chemical Corps., Medical Laboratories, Maryland, U.S.A.

The secondary degeneration causing enormous balloonings of the disintegrating axis cylinders severed from their neurones is one, yet this feature is not by itself diagnostic of nematodal damage, but only of trauma, as a cause. Eosinophilic infiltrations may be intense in and around the lesion, in spinal nerve roots, and in meninges, and as Ishii *et al.* (1952) have shown even in sciatic nerves, the latter perhaps as a tombstone of nematode migration. Inflammatory cellular reaction in the meninges may extend far beyond the levels of the malacia in grey or white matter. The totality of the process may be simply a residue of a devastating trek by a worm. The cellular inflammatory involvement of eosinophils may sometimes be slight, or even absent, and possibly its observation may be dependent on the stage of the lesion when it is seen. It is now indisputable that the whole morbid process of the natural disease, including the secondary degeneration extending beyond the primary focus, is virtually caused by mechanical trauma due to the meandering worm. This has been proved experimentally, for a replica of the acute malacic lesion (minus only the eosinophilic infiltration) was reproduced by simple traumatic puncture of the lumbar spinal cord of sheep by a sterile hypodermic needle (see illustrations in Innes, Shoho, and Pillai, 1952). Such an experimental animal shows an acute clinical paralysis analogous to that seen in the natural disease, evoked immediately by the needle severing spinal fibre tracts. A further experiment on needle trauma in a sheep has shown that this lesion is still recognisable a month later, and also the flaccid paralysis of hind legs lasts all that time.

This neuro-pathological disorder may yet prove to have a multiplicity of nematodal causes. We thus avoid prosecution of the idea that such a disease process can be caused only by *Setaria digitata*, or only by any species of *Setaria*. One is inclined to the opinion that nematodes in abnormal hosts may be specially attracted to invade the nervous system. Any worm, passing into, through, and out of the central nervous system, might produce the same pathological change involving any part of brain or cord. Then we extend our concepts of the syndrome to include comparable helminthic diseases which might affect the eye. Relating to the former instance, we would draw the attention of readers to the recent description of an identical clinical and pathological nervous disease occurring in sheep in the U.S.A., but caused by a newly-identified species of nematode, *Neurofilaria cornelliensis* (Kennedy, Whitlock, and Roberts, 1952). In connection with the latter citation we might refer to equine "worm-in-the-eye" caused by *Setaria spp* and its association with "Kumri" (an equine paralytic disease) in India (comparable to the nematodal paralysis of horses in Japan), and also to the description of nematode endophthalmitis in children by Wilder (1950), which may seem to be little different from equine "worm-in-the-eye."

Some believe with insistence that circumstantial evidence indicates that this same disease has occurred in many parts of the world in a variety of animal species for years, but that it has evaded true recognition. The reasons for the latter are comprehensible, if our descriptions of the pathology are read

carefully. With this in mind, we suggested that vague reports of a paralytic disease in deer in places as remote as Bavaria, Texas, and California might indicate a disease of this nature and that "Kumri" of horses in India, and its very apparent analogy in "wobblers" of young horses in the U.S.A., were other obvious "paralytic" disorders in which adequate pathological examinations were urgently required. We pointed out that a strange paralytic disorder of goats (and sheep) has long been known to occur in India and Persia, and might warrant similar pathological study.

This note deals with a caprine case from one region in India (Orissa), and offers further evidence on these points, and it is hoped that it may encourage those who are in a position to make detailed studies of any such paralytic cases in India. Crawford studied the caprine disease in Ceylon as far back as 1931, and he once mentioned that clinically, at least, the same disease had been seen by him in Karachi, India. Many annual reports from Muktesar (Imperial Veterinary Research Institute), starting from 1934, contain reference to a paralysis of goats which clearly did not come within the ambit of the easily recognised encephalitides, even though pathological descriptions are couched in vague general descriptive terms. Since the papers of Innes and Shoho, more information has come to light indicating that perhaps on clinical grounds the disease must be very widespread throughout India. For example, a letter from Dr. Tulsa Ram (Hissar, Punjab) has indicated the high prevalence of a seasonal paralytic disease in goats and sheep in that province. Obviously, therefore, there is some obscure paralytic disease in these species which has a wide geographical distribution in India alone from north-south-east-west, and as in Japan is not a matter of only occasional sporadic cases, for Dr. Ram mentioned that one series of his observations covered more than 100 paralysed goats.

The brain and parts of the spinal cord from one paralysed goat were removed, fixed in 10 per cent formalin, and dispatched from India for examination. This was carried out by Mr. Sri M. Patra, M.Sc., M.R.C.V.S., at one time Assistant Investigation Officer, Orissa, Cuttach, India. It is pointless to give detailed descriptions of the pathological findings in the study of this one specimen, for they would repeat what has been already defined.

In this specimen received, unfortunately there was some mechanical laceration and distortion of cerebral hemispheres due to damage in transit, and only very small portions of cord were available for examination. No naked-eye lesions were found on slicing the brain and cord by the knife, but this possible negative feature has been stressed before in neural nematodiasis, and has no diagnostic meaning. Nearly 30 whole transverse histological sections of different levels of the brain and cord were cut and stained by routine methods; there were many areas in the total volume of the nervous system which could not be studied at all. In the available collection of slides there was present an unmistakable focus of softening with a great abundance of fat-laden phagocytic glia deep in the superior frontal convolution of one cerebral hemisphere. This could be traced from the depths of the white matter to overlying grey matter

XUM

on the one hand, and in a most irregular fashion downwards and backwards involving internal capsule and basal ganglia on the other. Perivascular cuffing by mononuclears was present, but not pronounced, in and away from the lesion; eosinophilic participation in infiltrations was present but not prominent; ballooned swellings of disintegrated axis cylinders were present in the vicinity of the softening. No worms were found in or near the lesion. In some sections of the spinal cord (cervical level) there was also clear evidence of secondary degeneration, seen in the numerous swellings of axis cylinders in the ventro-lateral columns of white matter and mainly on one side, and without any reaction nearby. From what is known about the pathology of nematodiasis, these findings in the cord must have been related to some focus of malacia at a level in the brain stem higher than that of the portions of the cord sent. No outstanding mononuclear or eosinophilic infiltrations were present in the cerebrospinal leptomeninges, but there were spotty areas here and there in the depths of a few cerebral sulci and fissures.

Therefore, in the nervous system of this paralysed goat from India there was a microscopic patchy leptomeningitis and possibly two separate asymmetrical malacic foci with some perivascular cuffing and glial reaction around (the latter mainly phagocytic glia); one certain focus was in the frontal cerebral region probably involving the motor area, and the other was possibly in the upper cervical cord with secondary descending degeneration of motor tracts and mainly on one side.

The lesions of this goat were patently not those of a disseminated viral, or bacterial, encephalomyelitis. There were no inclusion bodies present. The process had been one of acute softening, and not inflammation *per se*. It had all the hallmarks of proven cases of cerebrospinal nematodiasis, except for the presence of a causal worm. The latter fact need not be surprising, for, as we have indicated before, the requisite search for worms in the nervous lesions may be a tedious one. In so far as our purpose is concerned, the object was achieved: namely, to make further steps towards identification of the nature of a paralytic caprine disease which has occurred in India for very many years. Lesions were found which permit of no other conclusion than they are identical with those now defined in cerebrospinal nematodiasis of either sheep, goats, or horses, and in either Japan, Korea, or Ceylon. This in itself should be a stimulus to those in a position to make more investigations of nervous diseases of animals in the Orient and elsewhere, for if the disease is not nematodiasis then it must be something entirely novel, and not reported hitherto.

A final comment might advisedly be made. In some sections from the above goat, the zone of softening in the cerebral focus on one side showed, of course, almost complete loss of myelin, and immense numbers of compound granular corpuscles and *gemästete Glia*. This lesion was in essence no different from that seen in some cases of very early and mild cases of swayback in lambs, with their small areas of gelatinous cerebral degeneration. Yet the asymmetrical irregular nature of the malacic lesion in nematodiasis is totally

XUM

unlike that in swayback. This resemblance, however remote, might be borne in mind because obviously there might be at least some superficial danger of confusing clinico-pathological comparisons between these two distinct diseases. [Swayback has never been described in goats, but in South America it has been noted in llama, vicuña, and alpaca.] On looking through files and slides, it is evident that there is hardly a single nervous disease of sheep which has not been mistaken for any or all of the others at some time or other. Possibly it is not commonly realised how formidable is the list of ovine nervous diseases clearly identified within this past thirty years. Nowadays we have the following entities to remember: rabies, listeriosis, louping-ill, scrapie, swayback, forms of cortical cerebellar atrophy, cerebrospinal nematodiasis, cerebrospinal coenuriasis (Gid), bacterial infections of the nervous system which might be pyæmic or might arise by contiguous spread of infection from vertebræ, tetanus, and some as yet unidentified so-called "enzootic encephalitides" of sheep, possibly viral, in some parts of the world. Plowright (1953), in Kenya, has very recently added yet another to the list — an acute, or subacute, seasonal paralysis of sheep associated with a unique nervous lesion which might appropriately be designated as a focal symmetrical spinal poliomalacia. As far as the writer is aware, this latter disease has no analogy in man or other animals. To this list we might add the extremely common muscular dystrophy (white muscle or stiff lamb disease) which has occurred in so many countries in Europe and in the U.S.A. There are again many ill-explained disorders of sheep which seem to have at least some "neurological" complication or background, e.g., as in pregnancy toxæmia. In view of the ease by which iso-allergic encephalitis can be produced in sheep by single injections of normal sheep brain with adjuvants, it might seem also that rare cases of post-vaccinal encephalitis could occur in countries where vaccine made from neural tissue has been used (e.g., in louping-ill), but has gone unrecognised. Nervous diseases of goats are in a different category and there are very few entities fully described (see Innes, 1951). A life-time could still be spent with profit in clinical-pathological investigations of nervous disorders of sheep and goats, but indeed these domesticated species are little different from all others. All require more elaborate study regarding nature and pathogenesis.

## REFERENCES

Innes, J. R. M. (1951): *Brit. vet. J., 107,* 187.
Innes, J. R. M., Shoho, C., and Pillai, C. Perumal (1952): *Brit. vet. J., 108,* 71.
Innes, J. R. M., and Shoho, C. (1952): *Brit. med. J., 2,* 366.
Ishii, S., *et al* (1953): *Brit. vet. J. 109,* 160.
Plowright, W. (1953): (In Press.)
Shoho, C. (1951): *Jap. J. vet. Sci., 71,* 117.
Shoho, C. (1952): *Brit. vet. J., 108,* 134.
Kennedy, D. C., Whitlock, J. H., and Roberts, S. J. (1952): *Cornell Vet., 42,* 118 and 125.
Wilder, H. (1950): *Trans. Amer. Acad. Ophth.,* p. 99.

XUM

# SOME OBSERVATIONS ON THE HELMINTH PARASITES OF SCOTTISH HILL CATTLE

By I. W. PARNELL, A. M. DUNN and G. M. MACKINTOSH.
*The Department of Zoology of the University of Edinburgh.*

## Introduction

During the last eight years a considerable number of observations have been made by Morgan and his co-workers (1947, 1950, 1951, 1952) on the incidence of helminths in Scottish hill sheep and on the problems caused by them. These observations, and those of Wilson *et al.* (1953) and Parnell *et al.* (1954), have shown that many species of worms increase rapidly during late winter and early spring and cause considerable losses in all ages of sheep, but especially in hoggs.

In recent years it has been widely advocated that there should be greater numbers of cattle on hill farms. Work was, therefore, undertaken to determine whether losses are caused by worms in Scottish hill cattle, and whether there are seasonal fluctuations in their worm burdens similar to those in sheep.

It is probable that in Scottish hill sheep 1,000 worm-eggs per gm. of fæces indicate infestations which do harm. In hill cattle pathogenic infestations may be indicated by considerably lower worm-egg counts.

Roberts, O'Sullivan and Riek (1951) working in Queensland, Australia, consider that, where *Hæmonchus contortus* is the dominant species, 1,000 eggs per gm., or more, frequently accompany serious symptoms of hæmonchosis in calves of 6 to 12 months old, but, where there are also counts of 300 e.p.g. or more of the hookworm, *Bunostomum phlebotomum,* or of *Bosicola radiatus* (syn. *Œsophagostomum radiatum*), or of both, even half this number of *Hæmonchus* may be definitely dangerous. Roberts *et al.* (1951), report that animals have been seen with conspicuous symptoms of hæmonchosis with egg counts of less than 100 e.p.g., when there were many immature worms, or more frequently when the resistance of the host caused a low worm egg output; they estimate that a yearling with a count of 1,000 *Hæmonchus* eggs per gm. will harbour over 2,000 and under 5,000 *H. contortus.*

The same authors state that 500 to 800 e.p.g., or even 300 e.p.g., of *B. phlebotomum* may indicate highly pathogenic infestations, especially if other species are present. Somewhat similar values are given by them to the eggs of *Bosicola radiatus.*

Roberts *et al.* also consider, however, that only when there are counts of 10,000 e.p.g. of *Cooperia* spp. are the infestations pathogenic in calves of three to five months old.

It has been stated (Anon. 1945) that 800 to 1,000 e.p.g. of *Trichostrongylus axei* represent pathogenic infestations in yearlings in Great Britain and that counts of over 400 e.p.g. in grown cattle are "suspicious."

Data on the egg counts of *Ostertagia* spp. and of *Chabertia ovina* which indicate pathogenic infestations are more limited, but probably *Ostertagia* spp.

could be grouped with *Trichostrongylus* spp. and probably *C. ovina* is only slightly less pathogenic that *B. phlebotomum* and *Oe. radiatum.*

In Queensland Roberts *et al.* (1951), found that most of the pathogenic infestations occur in beef cattle from 3 to 24 months old and in dairy cattle from 4 to 12 months of age.

The harmful effects of some heavy worm burdens can be suppressed if the nutritional level is high, but on most Scottish hill farms the nutritional level is only fairly good for a few months of the year, and for several months it is low, although hill cattle, unlike most hill sheep, are practically always hand fed in the winter. Therefore farmers on hill and marginal farms, where the infestations are always mixed, should not be complacent even if the worm-egg counts of their cattle are only a few hundred eggs per gm. of fæces. The financial loss from several animals which do not thrive may be greater than the loss from an occasional death, and animals which have suffered from helminthiasis often show the effects long after anthelmintic treatment has removed the cause.

## Methods

To obtain data on the importance of worms in hill cattle, farmers, cattlemen and shepherds were asked to send fæces samples from their cattle. From some farms only one set of samples were sent, but from others, samples were sent in periodically so that the worm-egg counts of particular animals could be followed throughout the year.

Samples were received from sixteen hill farms lying between Wester Ross. East Inverness-shire and the Borders.

So far it has not been practicable to make worm counts from the viscera of dead cattle, but fæces from hill cattle have been cultured and the helminth larvæ in them identified, to make a preliminary determination of the incidence of the common and important genera.

Five gm. of fæces were used when counting the worm-eggs in the samples from hill cattle, therefore the eggs have been counted in multiples of "20." *Nematodirus* and *Strongyloides* eggs were counted separately; the presence of large numbers of *Moniezia* eggs and of oöcysts of Coccodia was noted, and some of the fæces were examined for fluke eggs.

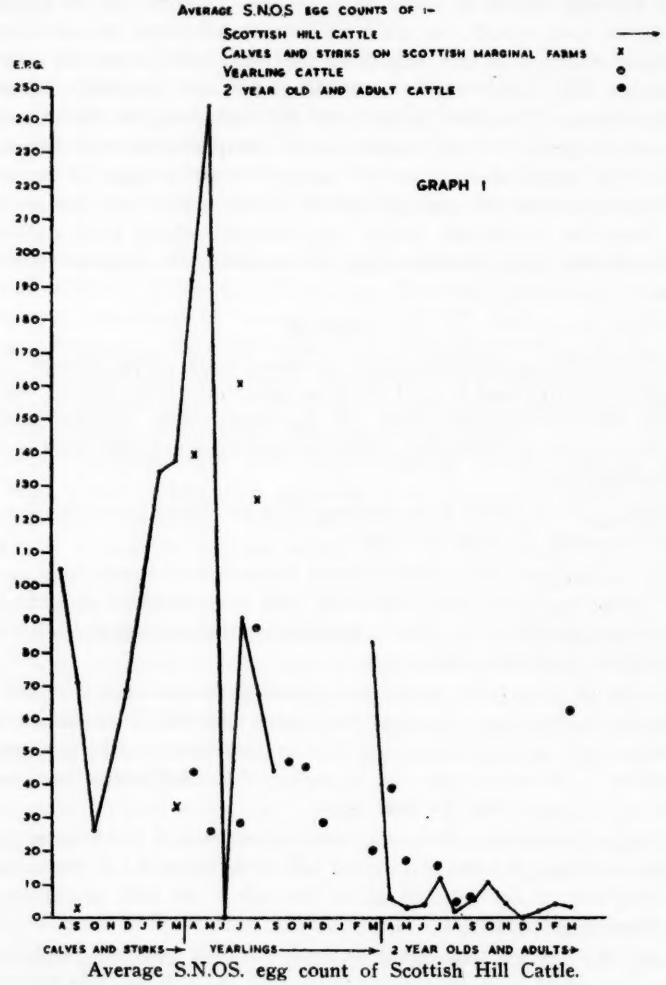
Calving of hill cattle, of course, tends to last over a much more prolonged period than lambing, but the majority of hill cattle calve in late winter or spring. On the majority of Scottish hill farms the calves are sold in the autumn or winter following their birth.

During the last few years some worm-egg counts have been made on cattle from four marginal type farms. On two of these farms calving continued throughout the year. Except on one farm, the majority of these cattle were young Ayrshire heifers; in one series of counts made in May on two-year-olds the majority had calved, but most of the other counts were on bulling or bulled heifers. Most of these heifers, on all four marginal farms, had grazed on high lying rough pastures in the summer and early autumn, and had been housed

at night during the winter, but had run out during the day on to fields near the steadings.

## Results

Table I shows the percentages of some Scottish hill cattle with different levels of " Other Strongyle "* infestations, estimated by worm-egg counts.




Average S.N.O.S. egg count of Scottish Hill Cattle.

Table II shows the percentages of cattle from the four marginal farms with different levels of " Other Strongyle " egg counts.

Graph I shows the monthly average worm-egg counts of the hill cattle and of the cattle from marginal farms.

* " Other Strongyles " include all the Strongyle eggs found in these cattle, with the exception of those of *Nematodirus spp.*

Table I and Graph I show that there is an increase in the worm-egg counts of calves or stirks on hill farms throughout the winter, and that a few of the counts may be sufficiently high to indicate that some harm is done to the host. Only a few yearling cattle from hill farms were examined, but the counts suggest that after the end of spring "Other Strongyle" worms are not likely to do them much harm. Table I and Graph I show that in adult cattle "Other Strongyles" are very seldom sufficiently numerous to be pathogenic.

Table II and Graph I suggest that a somewhat similar pattern of worm-egg production occurs in cattle on marginal farms, but perhaps with slightly higher counts in the bulling and bulled heifers.

Cultures were made from the fæces of some of the hill cattle; larvæ of

TABLE I

*Percentages of some Scottish Hill Cattle with various levels of infestation of "Other Strongyles."*

| Months | Approx. Age in Months | Number of Farms | Number of Cattle | Number of "Other Strongyles" eggs 0-20 | 40-100 | 120-200 | 220-400 | Over 400 | Highest Counts |
|---|---|---|---|---|---|---|---|---|---|
| Aug.-Sep. | 2-8 | 4 | 31 | 45.2 | 25.8 | 16.2 | 9.7 | 3.2 | 520 |
| Oct.-Nov. | 4-10 | 4 | 74 | 59.4 | 31.1 | 9.5 | 0 | 0 | 200 |
| Dec.-Jan. | 6-12 | 4 | 143 | 23.1 | 55.3 | 16.1 | 5.6 | 0 | 340 |
| Feb.-Mar. | 8-14 | 5 | 105 | 23.8 | 30.4 | 24.7 | 20.0 | 1.0 | 500 |
| Apr.-May | 10-16 | 2 | 19 | 15.8 | 15.8 | 10.6 | 42.1 | 15.8 | 620 |
| Jun.-Jul. | 12-18 | 2 | 11 | 63.7 | 18.2 | 9.1 | 0 | 9.1 | 580 |
| Aug.-Sep. | 14-20 | 1 | 14 | 57.1 | 28.6 | 14.2 | 0 | 0 | 200 |
| Oct.-Nov. | 16-22 | 1 | 9 | 100.0 | 0 | 0 | 0 | 0 | 0 |
| Dec.-Jan. | 18-24 | 1 | 6 | 100.0 | 0 | 0 | 0 | 0 | 0 |
| Feb.-Mar. | 20-26 | 2 | 13 | 38.5 | 38.5 | 7.7 | 7.7 | 7.7 | 420 |
| Apr.-May | Adult | 6 | 104 | 95.2 | 4.8 | 0 | 0 | 0 | 40 |
| Jun.-Jul. | „ | 5 | 101 | 94.0 | 5.9 | 0 | 0 | 0 | 60 |
| Aug.-Sep. | „ | 2 | 28 | 96.4 | 3.6 | 0 | 0 | 0 | 40 |
| Oct.-Nov. | „ | 6 | 176 | 96.6 | 2.8 | 0.6 | 0 | 0 | 120 |
| Dec.-Jan. | „ | 7 | 136 | 100.0 | 0 | 0 | 0 | 0 | 20 |
| Feb.-Mar. | „ | 7 | 147 | 97.3 | 2.7 | 0 | 0 | 0 | 80 |

*Hæmonchus contortus, Ostertagia* spp., *Trichostrongylus* spp., *Cooperia* spp., *Bunostomum* spp., *Chabertia ovina* and *Œsophagostomum* spp. were found.

Although the adults of *Hæmonchus contortus* are prolific egg layers, the larvæ were seldom very numerous; over-all they averaged about 9 per cent of the larvæ found in calves or stirks, yearlings and two-year-olds, and averaged 14 per cent of the larvæ from cultures of cow fæces; some were present in the majority of cultures. Only in a few districts and in a few animals is this species important in Scottish hill sheep.

In the cultures from Scottish hill cattle larvæ of *Ostertagia* spp. only averaged 6 per cent in calves or stirks, 9 per cent in yearlings and two-year-olds

and 22 per cent in cows. Species of this genus occur in larger proportions in Scottish hill sheep.

Larvæ of *Trichostrongylus* spp. averaged 13 per cent from the cultures of fæces from calves or stirks, yearlings and two-year-olds, and 28 per cent from the fæces of cows.

*Cooperia* spp. larvæ never constituted a major proportion of the larvæ found; the maximum was about 20 per cent, and the average 6 per cent, varying from 2 to 9 per cent in the three age groups.

In hill sheep although the hookworm, *Bunostomum trigonocephalum,* seldom exceeds a few scores, compared with hundreds or thousands of some other species,

TABLE II

*Percentages of cattle on four marginal farms in Scotland with various levels of infestation of "Other Strongyles."*

| Months | Approx. Age in Months | Age Group | Number of Farms | Number of Cattle | Number of "Other Strongyle" eggs 0-20 | 40-100 | 120-200 | 220-400 | Over 400 | Highest Counts |
|---|---|---|---|---|---|---|---|---|---|---|
| Sept. | 4-8 | Calves and Stirks | 1 | 20 | 95.0 | 5.0 | 0 | 0 | 0 | 50 |
| March | 10-12 | | 1 | 15 | 80.0 | 6.7 | 6.7 | 6.7 | 0 | 260 |
| Apr.-May | 9-12 | | 1 | 19 | 57.9 | 15.8 | 5.3 | 5.3 | 15.8 | 950 |
| July | 9-12 | | 1 | 5 | 20.0 | 40.0 | 0 | 40.0 | 0 | 350 |
| Aug. | 10 | | 1 | 2 | 0 | 50.0 | 50.0 | 0 | 0 | 150 |
| Apr.-May | 13-24 | Yearlings | 1 | 72 | 63.9 | 29.2 | 5.6 | 1.4 | 0 | 250 |
| July | 13-23 | | 1 | 48 | 64.6 | 31.2 | 2.1 | 2.1 | 0 | 300 |
| Aug. | 13-24 | | 1 | 51 | 52.9 | 27.5 | 11.8 | 5.9 | 2.0 | 1,700 |
| Oct.-Nov. | 17-21 | | 1 | 20 | 50.0 | 40.0 | 10.0 | 0 | 0 | 200 |
| Dec. | 14-24 | | 1 | 27 | 63.0 | 33.3 | 3.7 | 0 | 0 | 150 |
| March | 20-24 | | 2 | 13 | 84.6 | 15.4 | 0 | 0 | 0 | 100 |
| Apr.-May | 25 & over | 2-year-olds and adults | 3 | 103 | 80.6 | 14.6 | 3.9 | 1.0 | 0 | 300 |
| July | 25 & over | | 2 | 13 | 76.9 | 23.1 | 0 | 0 | 0 | 100 |
| Aug.-Sep. | 25-31 | | 2 | 20 | 90.0 | 10.0 | 0 | 0 | 0 | 50 |
| March | 25-31 | | 1 | 13 | 38.5 | 53.8 | 0 | 7.7 | 0 | 400 |

it is one of the most important nematodes. In hill cattle, even allowing for the fact that it is probably a fairly prolific egg-layer, *B. phlebotomum* occurs in relatively greater proportions. From cultures of fæces from calves or stirks this species constituted 51 per cent of the larvæ recovered, 58 per cent from yearlings and two-year-olds and 28 per cent from cows. There were considerable differences in the percentages found on different farms. On a farm in the Southern Uplands the average percentage of hookworm larvæ from young stock was 64 and from cattle of all ages on a farm in the hills north of the River Teith the average was 60, but from cows on a farm in the Cairngorms

the percentage was only 5; on this farm the herd had only been established for a few years. Only 4 per cent of the larvæ from a few heifers, which had recently been imported from Ireland, were those of hookworms.

Larvæ of *Chabertia ovina* constituted 14 per cent of the larvæ from the cultures of calf or stirk fæces and about 5 per cent from older cattle. From a farm near the Caledonian Canal the percentage was 33 in animals under a year old, but with this exception there was no evidence in these few observations to show that the incidence varied much in different parts of the country.

Larvæ of *Œsophagostomum* spp. were identified in samples from many farms. Nowhere, however, was this species plentiful; the overall percentage of *Œsophagostomum* spp. larvæ was under 3; it was slightly higher in cows than in younger cattle.

These limited number of observations suggest that there are only small variations in the proportions of these larvæ at different times of the year. However, there is perhaps a slight increase in the proportion of *H. contortus* in late spring or early summer, a decrease in the proportion of *Trichostrongylus* spp. in winter, and an increase in the proportion of *Chabertia ovina* in autumn and winter. Because these variations were slight, a more thorough survey would be necessary to establish whether they occurred every year on most hill farms.

Forty or more *Nematodirus* eggs were found in 3.2 per cent, 2.7 per cent, 10.5 per cent, 15.3 per cent and 15.3 per cent of the calves and stirks in Autumn-September, October-November, December-January, February-March and April-May respectively. *Nematodirus* eggs were only rarely found in animals over sixteen months old.

Very few eggs of *Strongyloides* spp. were found in the hill cattle; slightly more occurred in the fæces from cattle on marginal farms.

The percentage of calves and stirks on hill farms recorded as passing many tapeworm (*Moniezia* spp.) eggs were 3.2 in August-September, 20.3 in October-November, 14.7 in December-January and 17.1 in February-March; very few older animals were recorded as passing many eggs.

Numerous oöcysts of Coccidia were noted in 2.7 per cent of the hill calves or stirks in October-November and in 21.0 per cent in December-January; very few oöcysts were noticed in the fæces of older animals.

The incidence of *Fasciola hepatica* infestations varied considerably. On some farms the cattle appeared to be free from it while on others it was found in up to 40 per cent of them; eggs of this fluke were found in 8.4 per cent of 526 animals over about eight months old.

Five out of fifteen Cross Highland cows on a farm in the Southern Uplands were found to be harbouring *Paramphistomum* spp. These cattle had been on the farm for nearly three years, and were thought to have come originally from Argyll or the Outer Hebrides. Previous reports of *Paramphistomum* spp. in England and Scotland have suggested the West Highlands or the Western Islands as foci of infestation.

## Discussion

The results recorded in the present paper suggest that helminth parasitism, with the exception of fascioliasis, has very little pathological significance in adult Scottish hill cattle. The fæces from only a few yearlings on hill farms were examined and therefore no definite conclusions about the importance of the worm burdens of that age group can be drawn, but the counts do suggest that the infestations are heavier than those of adult cattle and lighter than those of calves and stirks.

Between August, when the calves were a few months old, and the following July, when they were over a year old, nearly 29 per cent had infestations of over 100 eggs per gm. of "Other Strongyles" and just under 4 per cent had counts of over 300 eggs per gm. It is probable, therefore, that while it is extremely rare for helminth parasites to kill a hill calf or stirk, infestations may result in loss of condition, especially as *Bunostomum phlebotomum* is one of the commonest species.

On hill farms and on marginal farms it is not a very common practice to keep many stirks. Where they are kept they are usually housed at night, and let out for a few hours during the day. The advantages of this practice must often outweigh the disadvantages, but some of the worm-egg counts from young stock suggest that this method may result in heavy worm burdens. When they are let out they graze any grass which is growing near the gate; grass growing near farm buildings is often particularly heavily contaminated, because cattle tend to defæcate when they are first released, and when they are waiting to come in they congregate in the same area. Moreover, because they are practically always fed inside, their outrun is often restricted and used year after year.

Because *B. phlebotomum* parasitises many Scottish hill cattle, worm-egg counts of only a few hundred eggs per gm., which might be considered to be too low to indicate harmful infestations in some countries, must be treated with suspicion, especially since the nutritional level of Scottish hill cattle is often low. However, counts of over 200 eggs per gm. seem to occur almost entirely in young stock. The significance of helminth infestations in adult cattle probably lies in their being reservoirs of infestation for young animals.

There is some evidence in the data in this paper that there is a "spring rise" in worm-egg production in stirks, corresponding to the spring rise in hoggs, but that this increase may be more dependent on management. The worm-egg counts in adult cattle were so low that there is no indication of the "spring rise" corresponding to that which occurs in ewes, but observations would have to be made on several herds at more frequent intervals to be sure that there is none.

The liver fluke, *Fasciola hepatica*, is less pathogenic to cattle than it is to sheep. However, its occurrence in hill cattle may be very important, because cattle can act as reservoir hosts of this fluke; and the consequences may be serious if cattle carry it to a hill which was previously free of it. On most hills suitable habitats for the snail, *Limnæa truncatula*, which harbours the inter-

mediate stages of fluke, are comparatively limited; but cattle, more than sheep, like to frequent the muddy patches where these snails live, and therefore may be more liable to defæcate and spread fluke eggs near these snails. Moreover, cattle, by their habit of puddling the ground around drains and wet places, are liable to increase the areas suitable as habitats for this snail, with the result that the snail populations increase; this increase is particularly likely to occur if liming has raised the *pH* of the soil and water.

Therefore, on hills where cattle and sheep are run together the cattle should be kept free of fluke by anthelmintic treatment. If a hill is free of fluke, treatments should be given before any bought-in cattle, which may be infested, are put on it, and it must be remembered that, even if 100 per cent of the flukes were killed by the first treatment, the cattle might continue to pass fluke eggs for some days, or perhaps weeks, after it, and therefore bought-in cattle should be kept for two or three weeks after treatment in places in which there is no danger from their spreading fluke eggs. Most cattle should be suspect, and particularly those from the West of Scotland or from Ireland.

**Summary**

Worm-egg counts on Scottish hill cattle have shown that nematodes in the alimentary tract of cows are unlikely to be sufficiently numerous to do harm, but that in young stock infestations may be sufficiently heavy to cause loss of condition.

The hookworm, *Bunostomum phlebotomum*, is one of the commonest species.

Hill cattle may be reservoir hosts of the liver fluke, *Fasciola hepatica*.

**Acknowledgments**

We wish to acknowledge our gratitude to the many farmers, cattlemen and shepherds who collected and sent fæces samples. Without this help this survey could not have been undertaken.

We also wish to thank Prof. J. Ritchie, C.B.E., and Prof. M. M. Swann, in whose department this work was done, and Dr. D. O. Morgan for their help and encouragement.

This research has been financed by the Agricultural Research Council.

REFERENCES

Anon. (1945): Report on Diseases in Farm Livestock. Sect. III, Parasitic Diseases of Cattle. *Nat. Vet. Med. Ass. Gt. Brit. & Ireland.* Publ. No. 8.

Morgan, D. O., Parnell, I. W., and Rayski, C. (1950): "Further Observations on the Seasonal Variation in Worm-Egg Output in Scottish Hill Sheep." *J. Helminth., 24,* 101-122.

Morgan, D. O., Parnell I. W., and Rayski, 1. (1951): "The Seasonal Variations in the Worm Burden of Scottish Hill Sheep." *J. Helminth., 25,* 177-212.

Morgan, D. O., Parnell, I. W., and Rayski, C. (1952): "Worm Infestations in Scottish Hill Sheep." *Scott. Agric., 32,* 46-53.

Morgan, D. O., and Sloan, J. E. N. (1947): "Research on Helminths in Hill Sheep with special reference to Seasonal Variations in Worm-Egg Output." *Scott, Agric., 27,* 28-35.

Parnell, I. W., Rayski, C., Dunn, A. M., and Mackintosh, G. (1954): "A Survey of the Helminths of Scottish Hill Sheep." *J. Helminth.* (In Press).

Roberts, F. H. S., O'Sullivan, P. J., and Riek, R. F. (1951): "The Significance of Fæcal Egg Counts in the Diagnosis of Parasitic Gastro-enteritis in Cattle." *Aus. vet. J., 27,* 16-18.

Roberts, F. H. S., O'Sullivan, P. J., and Riek, R. F. (1952): "The Epidemiology of Parasitic Gastro-enteritis of Cattle." *Aus. J. agric. Res., 3,* 187-226.

Wilson, A. L., Morgan, D. O., Parnell, I. W., and Rayski, C. (1953): "Helminthological Investigations on an Argyllshire Hill Farm." *Brit. vet. J., 109,* 179-190.

# OBSERVATIONS ON THE BLOOD SUPPLY OF THE BULL TESTIS

By A. KIRBY, B.Sc.
*Department of Anatomy, University of Liverpool*

THE first serious attempt to elucidate the vascular supply to the testis of the bull appears to have been made by Bimar (1888 *a* and *b*), who examined the gross vascularisation in man and a variety of domestic animals, using the ram and bull as examples of ruminants. At about the same time Jarisch (1888-89) published his classical paper on the comparative anatomy of the testicular vessels in the frog, lizard, a variety of domestic animals and man, and in this included an exhaustive account of the testicular artery and its branches and anastomoses in the bull (*Bos Taurus*).

The next available paper on this subject was the work of Picqué and Worms (1909) which, although devoted primarily to man, also contained an account of the comparative anatomy of the arterial supply to the testis of the bull and ram. This account shows marked variations from that of Jarisch, in particular in its statement that the testicular artery is the only artery of supply to the testis of the bull.

Wolfram (1942) published an account of the comparative anatomy of the testicular artery in which he gave measurements of the length of the spermatic cord and the length of the unravelled testicular artery.

Harrison (1949), in an account of the comparative blood supply of the mammalian testis carried out on forty-nine different species, includes an account of the vascularisation of the testis of *Bos Taurus*. This last account is, of necessity, rather brief in its description of the testicular artery and its branches outside the substance of the testis.

Owing to the lack of unanimity in the above-mentioned papers, the present research into the blood supply of the testis of the bull was undertaken in an attempt to provide a firm basis for a future study on the factors affecting fertility in the bull.

## Material and Methods

Twenty-one testes from eleven bulls of varying ages were used in this investigation; the bulls were of the species *Bos Taurus* and *Bos Indicus*, together with crosses between the two species. The testes were sent to this department by J. C. Bonsma, of the Agricultural Research Station, Pretoria, South Africa, to whom the author wishes to express his gratitude.

In Table I the breeds of the eleven bulls are given with their corresponding index numbers.

The testes were removed along with their spermatic cords by sectioning the cords at the level of the superficial inguinal ring. The testicular artery of each testis was injected with a radio-opaque injection mass ("Chlorbismol," May & Baker Ltd.) with a particle size of 12$\mu$, at a pressure of 120 mm. of

PLATE I

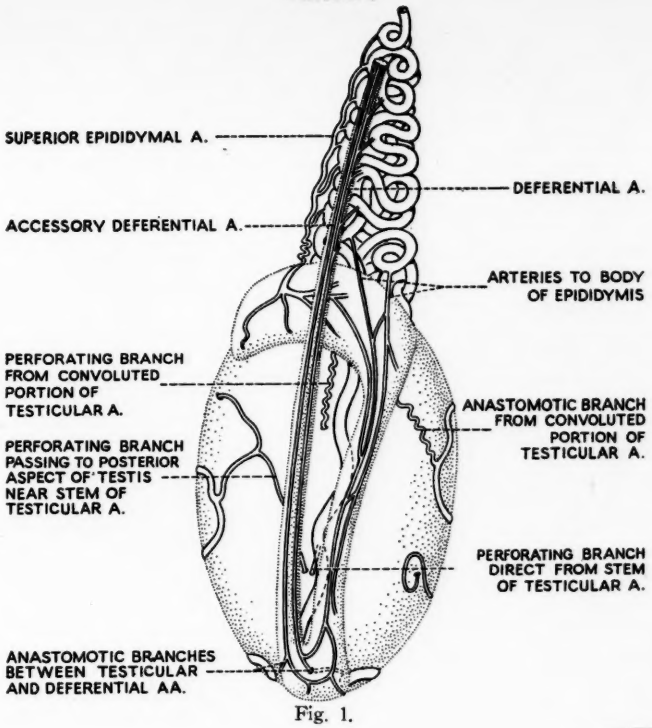

SUPERIOR EPIDIDYMAL A.
DEFERENTIAL A.
ACCESSORY DEFERENTIAL A.
ARTERIES TO BODY OF EPIDIDYMIS
PERFORATING BRANCH FROM CONVOLUTED PORTION OF TESTICULAR A.
ANASTOMOTIC BRANCH FROM CONVOLUTED PORTION OF TESTICULAR A.
PERFORATING BRANCH PASSING TO POSTERIOR ASPECT OF TESTIS NEAR STEM OF TESTICULAR A.
PERFORATING BRANCH DIRECT FROM STEM OF TESTICULAR A.
ANASTOMOTIC BRANCHES BETWEEN TESTICULAR AND DEFERENTIAL AA.

Fig. 1.

Fig. 2.

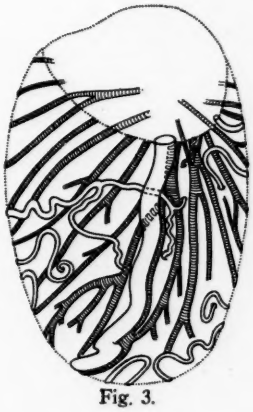


Fig. 3.

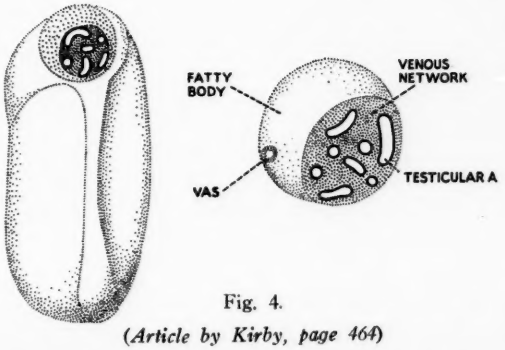



Fig. 4.

*(Article by Kirby, page 464)*

Fig. 5.

Fig. 6.

(*Article by Kirby, page 464*)

XUM

## PLATE III

### DESCRIPTION OF FIGURES.

Fig. 1.—Illustration showing the arterial supply to the testis of the bull; the main arterial branches shown in this figure are described in the text.

Fig. 2.—Illustration of the arterial pattern at the lower pole of the testis drawn from testis I.E.S.L. Note the characteristic mode of diversion of the artery in this situation.

Fig. 3.—Illustration showing the venous drainage of the body of the testis. Arteries outlined, veins outlined and horizontally shaded. In this specimen the epididymis has been completely removed to display the superior pole of the testis.

Fig. 4.—Postero-lateral view of a testis in which the spermatic cord has been sectioned near to the body of the testis (on the left), and also (on the right of the figure) a diagram of a typical cross-section of the spermatic cord in this region shown in greater detail and demonstrating the comparatively large size of the fatty body.

Fig. 5.—Lateral radiograph of testis LAR with arteries injected with "Chlorbismol." The deferential, accessory deferential, and superior epididymal arteries, and the arterial anastomoses at the lower pole of the testis are demonstrated.

Fig. 6.—Lateral radiograph of testis 103L with arteries injected with "Chlorbismol." In this testis the stem testicular artery divides high in the spermatic cord; the two divisions can be seen taking independent courses across the body of the testis.

Fig. 7.—Lateral radiograph of testis 373L. A convoluted arterial branch arising from the testicular artery in the lower part of the spermatic cord and piercing the body of the testis at about the junction of middle and lower thirds of the body is clearly shown.

Fig. 8.—Lateral radiograph of testis 430L. The helical arrangement of the superior epididymal artery just above the head of the epididymis is shown and the arrangement of the arteries supplying the internal substance of the lower pole of the testis may be seen.

Fig. 9.—Radiograph of a transverse section of testis 338R which was injected with "Chlorbismol" previous to sectioning. Perforating arteries are seen coursing towards the central mediastinum and branches dividing for the supply of the substance of the testis are seen passing peripherally.

XUM

PLATE IV

Fig. 7.

Fig. 8.

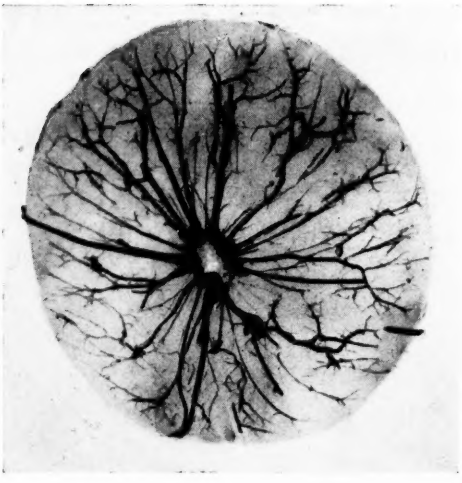


Fig. 9.

(*Article by Kirby, page 464*)

mercury. Lateral radiographs were then taken of all the testes; from a study of these radiographs it was obvious that arterial filling was complete, while in no case was there any overflow of the injection mass into the venous system.

The length of the spermatic cord was measured in all twenty-one cases. This reading was taken from the point at which the cord was sectioned to the

TABLE I

| Breed | Index No. | Length of Cord cm. | Length of Artery cm. |
|---|---|---|---|
| Afrikaner ... ... ... | 430L | 7·5 | — |
| „ ... ... ... | 430R | 7·7 | 99.0* |
| „ ... ... ... | 440L | 6.5 | 97.0 |
| „ ... ... ... | 440R | 8.0 | — |
| White Afrikaner ... ... | 208R | 15·5 | 183.0 |
| Langjan's Afrikaner ... | LAL | 18.5 | 270.0 |
| „ ... | LAR | 18.9 | 243.0 |
| Hereford ... ... ... | 373L | 8.9 | 134·5 |
| „ ... ... ... | 373R | 8.7 | — |
| „ ... ... ... | 395L | 10.0 | 112.0 |
| „ ... ... ... | 395R | 8.5 | — |
| Shorthorn ... ... ... | I.E.S.L. | 15·5 | 274.0 |
| „ ... ... ... | I.E.S.R. | 14·3 | 279.0 |
| Hereford x Afrikaner ... | 103L | 18.0 | 238.0* |
| „ ... | 103R | 18.7 | 295·5 |
| „ ... | 338L | 10.9 | 196.0 |
| „ ... | 338R | 11.0 | — |
| „ ... | 459L | 9.0 | 190.0 |
| „ ... | 459R | 8.0 | — |
| Shorthorn x Afrikaner ... | 359L | 7·9 | 149.0 |
| „ ... | 359R | 8.8 | — |

*Testicular artery dividing in spermatic cord to give two equal-sized branches. The length given is the sum of the length of the stem artery and the average length of the two divisions.

point on the upper pole of the body of the testis where the convolutions of the testicular artery ceased and the artery began its undulating course down the body of the testis. This latter point is somewhat below the level of the highest point on the body of the testis. The cord was straightened out and the measurements taken to an accuracy of 0.1 cm.

The testicular artery was carefully dissected out in its course within the spermatic cord in fourteen testes, at least one testis from each of the eleven animals being dissected. In three cases both arteries from an individual animal were dissected out. The artery was dissected from the point at which the spermatic cord was cut, i.e., the level of the superficial inguinal ring, to that point where its convolutions cease on the upper pole of the testis and the artery commences its slightly undulating course down the posterior aspect of the testis.

To facilitate measurement of the dissected artery it was threaded on

XUM

S.W.G.18 copper wire; thus the convolutions of the artery were straightened out without the artery being stretched. By this method a reading of the length of the artery was obtained which was accurate within very small limits.

Sections of the seven undissected spermatic cords were cut with a razor and an endeavour was made to measure the thickness of the wall of the testicular artery in these sections, using a travelling microscope. However, this procedure was found impracticable as the tunica adventitia of the testicular artery was seen to merge into the connective tissue of the walls of the venous network surrounding the artery. These sections were also used to demonstrate the comparatively large size of the fat body in the spermatic cord of the bull.

Finally, transverse sections of comparable thickness were cut from similar situations in the bodies of all the testes available. These sections were examined radiographically in order to study the internal vascularisation of the testis in the different breeds.

## Results

### (1) *The Testicular Artery and its Branches*

Before reaching the testis the testicular artery describes a great number of convolutions in close apposition to each other; thus the artery forms an elongated vascular cone with its apex at the superficial inguinal ring and its base on the superior pole of the testis. In the testes examined this cone varied in length from 7.5 cm. to 18.9 cm., and the length of artery coiled within it varied from 97.0 cm. to 295.5 cm.

Some idea of the degree of convolution of the artery within the vascular cone is given by the fact that the length of the unravelled artery was found to vary between 11.2 and 21.1 times the length of the vascular cone, the average value for length of unravelled artery divided by length of vascular cone being 15.5. It is interesting to compare these findings with those of Wolfram (1942), who measured the testicular artery from the superficial inguinal ring to the lower pole of the testis, and found that the length of the unravelled artery varied between 3 and 10 times the length of the vascular cone.

Numerous small branches are given off from the testicular artery within the spermatic cord. The majority of these branches supply the structures within the spermatic cord and, by anastomosing with each other, form an anastomotic chain of small arteries down the anterior aspect of the spermatic cord (Fig. 6). This anastomotic channel is largely expended in supplying the head of the epididymis (superior epididymal artery), and in supplying the remnant of the fat body which occupies an appreciable area of the lower part of the spermatic cord in the bull (Fig. 4). Several small branches from within the cord anastomose with, or go to form, the deferential and accessory deferential arteries.

In most of the testes examined one or more small arteries from the cord were seen to pass on to the body of the testis, the most commonly occurring branch being one which passes down the posterior aspect of the testis immediately anterior to the testicular artery. This branch usually arises from the testicular artery in the lower part of the spermatic cord and takes a convoluted course down the body of the testis before piercing the substance of the testis. Thus in

thirteen testes this branch was found to exist, but the point at which it pierces the testis is by no means constant. In seven cases the branch pierced the posterior aspect of the testis at the junction of upper and middle thirds of the body, in five cases it entered at the junction of lower and middle thirds (Fig. 7), and in the remaining case this branch was large and divided to give two branches which entered the testis at the junction of upper and middle thirds and the junction of lower and middle thirds of the body respectively. In none of the thirteen testes in which the above branch from the cord was found was there any surface anastomosis between this artery and other branches of the testicular artery on the surface of the testis (Fig. 1).

A small branch of similar origin to the above may pass on to the posterior surface of the testis, usually in fairly close relation to the testicular artery, and terminate without piercing the testis by anastomosing directly with one of the terminal surface branches of the testicular artery (Fig. 1). This anastomosing branch was found in ten cases in the twenty-one testes examined; it usually takes a convoluted course over the surface of the testis, and in two cases it was represented by two branches from the cord taking similar courses on the body of the testis.

In only one of the testes examined was a branch found to pass from the testicular artery within the cord directly on to the anterior aspect of the testis. This branch terminated by anastomosing with a terminal surface branch of the testicular artery.

In four testes a small branch was found to arise from the deep aspect of the testicular artery during its course over the posterior aspect of the testis. When present, this branch pierces the substance of the testis almost immediately, entering the testis at the junction of the lower and middle thirds (Fig. 1).

Occasionally a terminal surface branch of the testicular artery passes on to the posterior aspect of the testis and sends a perforating branch into the testis at the junction of lower and middle thirds of the body and in close relation to the testicular artery (Figs. 1 and 3).

Apart from the above-mentioned occasional branches, the posterior aspect of the testis (i.e., that part of the testis associated with the stem of the testicular artery) is devoid of perforating arterial branches of any appreciable size; this also applies to the superior pole of the testis. Elsewhere on the surface of the testis a random distribution of perforating branches derived from the terminal surface branches of the testicular artery exists.

The arterial pattern of the lower pole of the testis was studied and a remarkable uniformity of pattern was observed. The testicular artery reaches the lower pole of the testis after a convoluted sub-albugineal course down the posterior aspect of the testis, and only rarely in this part of its course are any branches given off from the testicular artery (*vide supra*). After reaching the lower pole the artery divides dichotomously, the two branches so formed usually being of unequal size. The larger of these branches takes a convoluted course of varying length over the inferior pole before itself dividing either on the inferior pole or on the lower part of the anterior surface of the testis (Fig. 2).

XUM

Thus the final result of these two divisions is three arteries which take a convoluted course over the anterior and lateral surfaces of the testis.

An interesting variation of the testicular artery was found in three testes. The testicular artery divides shortly after leaving the superficial inguinal ring to give two branches of approximately equal size which occupy their own territory in the spermatic cord, the two branches in the cord being easily separated from each other below the level of bifurcation of the stem artery. This arrangement was found unilaterally in the Hereford x Afrikaner bull 103 where the left artery divided at a high level, and bilaterally in the testes of the Afrikaner bull 430.

In these cases the more posterior of the two divisions took a similar course to the normal undivided testicular artery, and after reaching the lower pole divided in the characteristic manner (*vide supra*).

In all three testes under consideration the slightly more anterior of the two divisions of the testicular artery in the cord runs on to the posterior surface of the testis and immediately takes an oblique course under the tunica albuginea across the body of the testis to reach the anterior surface, where it divides in the manner of a normal testicular artery and then gives rise to a large number of branches which ramify over the upper half of the body of the testis (Fig. 6). The posterior division provides branches which ramify over the lower half of the testis; these branches do not anastomose on the surface of the testis with branches of the anterior division, and therefore the surface distribution of the testicular artery is divided into two distinct territories.

This separate arterial supply to the upper and lower parts of the surface of the testis is interesting in that it was also found to occur in some testes in which the testicular artery remained undivided until reaching the inferior pole of the testis. Thus in four cases (103R, 395R, 338L and LALT) it was found that, after the artery had divided in the normal manner at the inferior pole, the smaller of the two primary branches takes an undulating course up the anterior aspect of the testis and is expended in ramifying over the upper half of the anterior surface. The territory supplied by this branch is usually much smaller in area than the territory supplied by the inferior primary division of the testicular artery.

It is noteworthy that this condition appeared to occur unilaterally when the testicular artery reached the inferior pole of the testis before dividing; thus the four testes just mentioned were from four different animals, although 103R is the companion testis to one in which the testicular artery divided within the cord.

(2) *Arterial Supply to Vas Deferens and Epididymis*

The formation of the superior epididymal artery by a series of anastomoses between small branches from the convoluted part of the testicular artery has already been noted. Immediately above the head of the epididymis the superior epididymal artery describes three or four closely apposed helical turns. Upon reaching the head of the epididymis it divides into several small branches which are distributed to the head and the upper part of the body of the epididymis;

some of these branches make an anastomosis with branches of the arteries supplying the lower part of the body of the epididymis.

In the majority of the testes examined the radio-opaque injection mass has shown up clearly several small arteries arising from the convoluted part of the testicular artery and passing from the lower part of the arterial cone on to the body of the epididymis for the supply of this structure. These branches gain anastomosis with branches of the superior epididymal artery superiorly and with the deferential and accessory deferential arteries inferiorly (Fig. 1).

The deferential and accessory deferential arteries were both found to be present in all cases, both arteries receiving communicating branches from the testicular artery within the cord. Branches of the deferential and accessory deferential arteries anastomose with branches of arteries supplying the body of the epididymis and with branches of the testicular artery in the region of the tail of the epididymis and lower pole of the testis. The latter anastomosis between the deferential arteries and the testicular artery is extremely good in most cases (Fig. 5).

Communicating branches between the deferential and accessory deferential arteries are found at varying levels along their course on the vas deferens, and a fairly large communicating branch was found lying on the vas deferens below the level of the spermatic cord in five of the testes examined. This branch corresponds to a similarly situated communicating branch depicted by Jarisch (1888-89).

(3) *Internal Vascularisation of the Testis*

The body of Highmore (mediastinum testis) of the bull is situated almost centrally within the testis but usually shows a slight posterior inclination from above downwards; it is deficient at the lower pole of the testis.

Arterial branches, after piercing the testicular substance, take a practically straight unbranching course towards the body of Highmore (Fig. 9). After reaching it they bend sharply upon themselves and divide to produce several branches which course centrifugally, or the whole perforating artery may course centrifugally for a short distance before dividing. The main perforating artery may, after reaching the body of Highmore, make a right-angled bend and take a short course along the body of Highmore before dividing and passing centrifugally. The fine branches so produced divide still further as they pass peripherally, and supply numerous small branches to the substance of the testis, the terminal branches reaching to the periphery of the gland.

In the bull the interlobular septa are deficient, and it is thus difficult to state whether or not the radially arranged perforating arteries take an interlobular course.

In no case were the perforating arteries seen to bend back upon themselves before reaching the body of Highmore, and thus in this respect the internal vascular architecture of the testis of the bull differs markedly from that of man as described by Harrison and Barclay (1948).

The arterial supply to the lower pole of the testis is by means of fine

arterial branches passing downwards from the region of the lowest part of the body of Highmore (Fig. 8).

(4) *Venous Drainage of the Testis*

Bimar (1888 *a*), in his comparative study of the vascularisation of the testis, gave an excellent account of the venous drainage of the testis of the bull, and my own work in this respect serves only to support his findings.

Very few veins of any appreciable size were found on the anterior surface of the testis where the tunica vasculosa was occupied largely by the terminal surface branches of the testicular artery. The posterior surface of the testis, however, is traversed by a large number of voluminous veins which run a relatively straight course towards the superior pole of the testis, where they divide and anastomose many times to form a prodigious quantity of small veins. The pampiniform plexus is thus formed as a vast venous network surrounding the testicular artery in its convoluted course within the spermatic cord, and in intimate contact with the arterial wall (Figs. 3 and 4). Several large veins are also found running an almost straight course from the body of the testis to the superficial inguinal ring. These veins lie in the remnant of the fat body and are in close apposition to the arterial cone with its interlacing venous network.

The veins of the venous network increase in size and decrease in number as they approach the superficial inguinal ring and prepare to form the two testicular veins.

## Discussion

The testicular artery during its extensive course through the spermatic cord lies in the midst of the pampiniform venous plexus and gives off branches to the substance of the cord, the vas deferens, the epididymis, and usually sends a branch on to the body of the testis for the supply of the substance of the testis.

Several of the findings described above are in agreement with those of Jarisch (1888-89), although I am unable to confirm his description of the branches of the testicular artery, particularly the arterial supply to the epididymis. Thus Jarisch describes an artery destined for the supply of the epididymis which arises from the testicular artery before the latter commences coiling. This epididymal branch divides into medial and lateral branches, the medial branch passing to the body and tail of the epididymis and anastomosing with the deferential artery, and the lateral branch being destined for the supply of the head and body of the epididymis.

Bimar (1888) describes the epididymis as being supplied by three or four flexuous branches arising from the coiled portion of the testicular artery.

I have drawn attention to the superior epididymal artery and its peculiar origin in the bull when compared with the origin of this artery as a separate single stem from the testicular artery in the rat and man, and to branches arising from the convoluted part of the testicular artery for the supply of the body of the epididymis which gain anastomosis with the superior epididymal artery and the deferential and accessory deferential arteries.

Picqué and Worms (1909) drew attention to the arterial supply to the

head of the epididymis in the bull, which they describe as arising by two branches from the testicular artery. They also describe a single branch of the testicular artery supplying the tail of the epididymis, but are unable to find a deferential artery and deny the existence of such a vessel. They conclude that the testicular artery is the only artery of supply to the testis of the bull, and takes over the supply of the human deferential and cremasteric arteries.

Jarisch depicted a deferential and an accessory deferential artery in the bull, and on radiographic examination of the testes which I have studied, these two arteries are seen to be present in all cases. Both these arteries receive numerous communications from the convoluted part of the testicular artery (Fig. 1).

The arteries to the vas deferens of the bull are derived from branches of the testicular, umbilical and internal pudic arteries (Sisson and Grossman, 1938); in the testes examined the branches to the deferential arteries from the testicular artery were sufficiently large and numerous to allow complete filling of the deferential and accessory deferential arteries with a radio-opaque mass injected into the testicular artery. These arteries gain anastomotic connection with the arteries to the body of the epididymis and with the branches of the testicular artery at the lower pole of the testis.

Previous investigators have stated that the testicular artery divides into two to four convoluted branches on the lower pole of the testis, but my investigations lead me to believe that the mode of division of the artery in this situation is by no means as variable as the literature would lead us to believe. Thus in all the cases which I examined, a common pattern of division of the artery was observed at the lower pole of the testis (Fig. 2).

The internal vascular architecture of the testis of the bull was seen to differ markedly from that described in the human testis by Harrison and Barclay (1948).

During the course of these investigations it came to my notice that the remnant of the fat body in the bull occupies an appreciable amount of the spermatic cord (Fig. 4) and is richly supplied by arterial branches from the convoluted portion of the testicular artery and from the superior epididymal artery. This structure does not appear to have been mentioned by previous investigators.

My findings on the venous drainage of the testis are in complete agreement with those of Bimar (1888).

The extensive course of the testicular artery within the spermatic cord and upon the body of the testis, and its intimate relationship to the veins draining the testis, suggests that cooling of the arterial blood may occur before it is distributed to the substance of the testis, and this has, in fact, been shown to be true for the ram by Harrison and Weiner (1948). Since, as may be seen from Table I, there are noticeable discrepancies in the lengths of the testicular

XUM

artery in Afrikaner and European breeds of bull, it may be presumed that differences in the thermo-regulatory capacity of the vascular arrangements may also exist. This problem will be considered in a further communication to be published elsewhere.

**Summary**

(1) The vascular supply of the testis of the bull (*Bos Taurus* and *Bos Indicus*) has been studied by the methods of dissection and arteriography in a series of twenty-one testes.

(2) An account of the branches arising from the convoluted portion of the testicular artery is given, and also the occasional branch from the artery during its course down the posterior aspect of the testis is mentioned.

(3) The mode of division of the testicular artery, its pattern within the testis, and the venous drainage, are described.

(4) An account is given of the blood supply to the epididymis and vas deferens, and mention is made of the anastomotic connections between deferential, epididymal and testicular arteries.

**Acknowledgments**

I wish to acknowledge the valuable advice and criticism which I have received from Prof. R. G. Harrison. I would also like to thank him for suggesting this study and for allowing me access to his personal translations of papers by Bimar, Jarisch and Wolfram.

My thanks are also due to Messrs. L. G. Cooper and C. FitzSimon for their technical assistance in the preparation of the radiographs and photographs in this paper.

REFERENCES

Bimar, M. (1888 *a*): "Recherches sur la Distribution des Vaisseaux Spermatiques chez les Mammiferes et chez l'Homme," *J. Anat.*, Paris, *24*, 265-273.

Bimar, M. (1888 *b*): "Recherches sur la Distribution des Vaisseaux Spermatiques chez divers Mammiferes," *C. R. Acad. Sci.*, Paris, *106*, 80-83.

Harrison, R. G. (1949): "The Comparative Anatomy of the Blood Supply of the Mammalian Testis," *Proc. Zool. Soc. Lond.*, *119*, 325-344.

Harrison, R. G., and Barclay, A. E. (1948): "The Distribution of the Testicular Artery (Internal Spermatic Artery) to the Human Testis," *Brit. J. Urol.*, *20*, 57-66.

Harrison, R. G., and Weiner, J. S. (1948): "Abdomino-testicular Temperature Gradients," *J. Physiol*, *107*, 48-49 P.

Jarisch, A. (1888-89): "Ueber die Schlagadern des menschlichen Hodens," *Ber. naturw.-med. Ver. Innsbruck*, *18*, 32-79.

Picqué, R., and Worms, G. (1909): "Les Voies Anastomotiques de la Circulation Arterielle Testiculo-Epididymaire," *J. Anat.*, Paris, *45*, 51-64.

Sisson, S., and Grossman, T. D. (1938): "The Anatomy of the Domestic Animals." 3rd edition. London: Saunders.

Wolfram, W. (1942): "Zur anatomie der arteria spermatica interna," *Klin. Wschr.*, *21*, 1126-27.

# THE CATTLE TRYPANOSOMIASES—EXPERIMENTS ON THE MAINTENANCE OF CATTLE IN TSETSE-INFESTED COUNTRY BY MEANS OF DRUG PROPHYLAXIS

By R. N. T.-W.-FIENNES.

*East African Veterinary Research Organisation, Kabete, Kenya.**

DAVEY (1950) described attempts to keep cattle in tsetse-infested country at Kiboko in Kenya. He tested the prophylactic properties of antrycide at various dosages, using different combinations of the two salts—the insoluble dichloride and the soluble dimethyl-sulphate.

The present paper carries the history of Davey's groups of cattle from the 26th week to nearly two years. The cattle were sent to Kiboko in two groups on 19.10.48 and 24.11.48. Table I gives a summary of the results:—

TABLE I

*Giving a summary of results with antrycide protected cattle sent to Kiboko.*

| Group | No. of cattle | Treatment | Nos. sent back to Kabete | Nos. which died before 30.9.49 | Nos. surviving at 30.9.49 | Percentage death rate up to 30.9.49 of cattle which remained at Kiboko |
|---|---|---|---|---|---|---|
| Controls | 10 | Nil | Nil | 10 | Nil | 100% |
| I | 9 | 1.5 G.DMS plus 2.0 G. DiCl. | 4 | 3 | 2 | 60% |
| II | 10 | 3.0 G.DMS | Nil | 4 | 6 | 40% |
| III | 14 | 1.5 G.DMS plus 0.5 G. DiCl. | 1 | 11 | 2 | 85% |
| IV | 28 | 1.5 G.DMS plus 1.0 G. DiCl. | 11 | 9 | 9 | 53% |

DMS = Antrycide dimethyl-sulphate.
DiCl. = Antrycide dichloride.

Further results with these cattle are studied under three main heads:—

(1) those which were brought back to Kabete on 31.3.49,
(2) those which died at Kiboko prior to 30.9.49,
(3) those surviving at Kiboko on 30.9.49.

The date 30.9.49 is selected arbitrarily but is convenient since deaths had for the time halted and the writer, who had been on long leave in the United Kingdom, was again able to give detailed supervision to the experiments.

### (1) Histories of Cattle Brought Back to Kabete on 31.3.49

The following is a summary of the results obtained from 16 cattle, which

*Present address:—16 Peaslands Road, Saffron Walden, Essex, England.

were brought back to the Kabete laboratory on 31.3.49 at a time when the blood smears were still negative :—

| | | |
|---|---|---|
| Blood smears remained negative | ... | 4/16 |
| *T. vivax* became positive | ... ... | 2/16 |
| *T. congolense* became positive | ... ... | 10/16 |

The majority of the cattle did not show positive blood slides for 6 to 8 weeks after their return from Kiboko. One group of these cattle had been admitted to the " fly " area two weeks after receiving the prophylactic injection; a second group three months. There was no difference in infection rate between these two groups. The two groups had been in contact with tsetse flies for six months and four months respectively.

The small number of *T. vivax* infections is surprising, since this parasite usually appeared somewhat earlier than *T. congolense*. In all cases, the disease which developed was of a benign type and only two deaths occurred as a result of it. The ten remaining cattle, which developed trypanosomiasis, recovered without treatment. Pooled blood from the cattle, which had become infected with *T. congolense,* was injected into three clean cattle. These all developed virulent trypanosomiasis, from which they died.

It is evident from this that the benign nature of the disease was dependent on the host's developed powers of resistance and not on attenuation of the parasites.

All the cattle were sold on 21.6.49 except for three, whose histories are given below :—

*No. 5847* had become infected with *T. congolense,* but the blood smears remained negative after 7.10.49. On 4.1.50, it received 5 c.c. of TAB vaccine subcutaneously, followed by three injections of 5 c.c. of 1 : 10,000 adrenaline subcutaneously daily on 4.1.50, 5.1.50 and 6.1.50. On 11.1.50 a gland slide showed small numbers of *T. vivax,* which had never previously been diagnosed. It was killed for autopsy on 23.1.50 and trypanosomes were found in the heart.

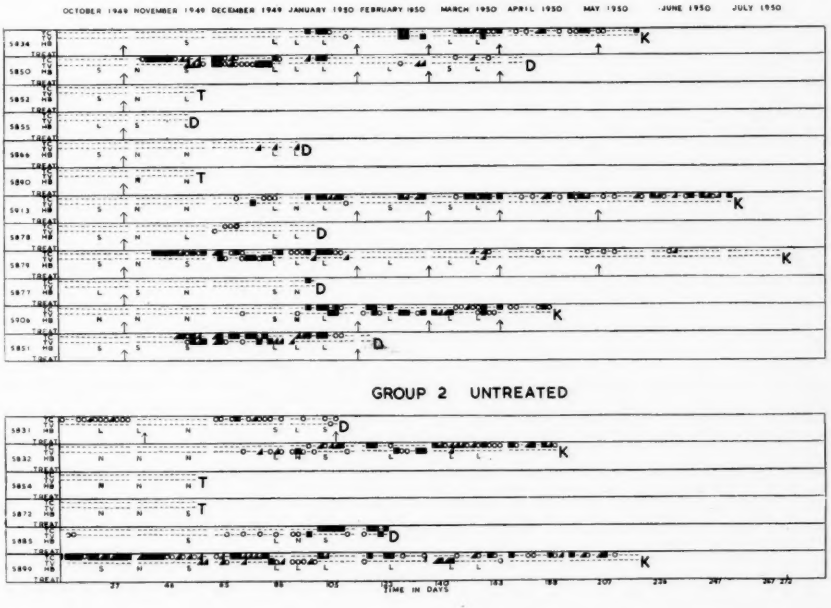
*No. 5888* showed one trypanosome in a blood smear on one day only; it appeared clinically to be infected. It received the same TAB and adrenaline treatment as No. 5847 on 4.1.50 to 6.1.50, but with negative results. It was killed on 25.5.50 and autopsy was performed. The animal at the time of death had recovered condition but sections showed heart lesions and scanty trypanosomes were revealed, mostly in a state of lysis.

*No. 5896* became negative to *T. congolense* on 21.9.49. On 10.11.49, *T. vivax* which had not previously been diagnosed was encountered in a gland smear and was subsequently present intermittently in blood smears until 3.2.50. On 5.4.50 *T. congolense* reappeared in a gland smear, was present in the blood smear on 6.4.50 and in the gland smear again on 12.4.50; numbers present were small. This animal has since shown no further positive blood or gland smears.

**(2) Cattle Which Died at Kiboko Prior to 30.9.49**

Results for those cattle which died prior to 30.9.49 are given in Table I.

CHART NO. I SHOWING RESULTS OF BLOOD AND GLAND SMEAR EXAMINATIONS ON ANTRYCIDE TREATED CATTLE AT KIBOKO



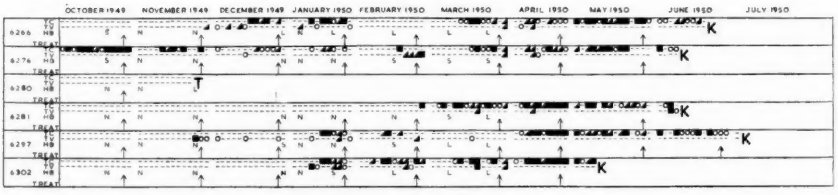

\- NO PARASITES SEEN IN 600 FIELDS OF A THICK SMEAR
TC T CONGOLENSE
TV T VIVAX
TREAT TREATMENT
T TRANSFERRED TO KABETE LABORATORY
D DIED
K KILLED
† TREATED

■ HEAVY INFESTATION – IE – MORE THAN ONE PARASITE IN 2 FIELDS OF A THIN SMEAR
◢ MODERATE INFESTATION – IE – MORE THAN 10 PARASITES IN 600 FIELDS OF A THIN SMEAR
○ LIGHT INFESTATION IE LESS THAN 10 PARASITES IN 600 FIELDS OF A THIN SMEAR
N HAEMOGLOBIN 70% AND OVER
S HAEMOGLOBIN SUBNORMAL – IE – 60% TO 70%
L HAEMOGLOBIN LOW – IE – BELOW 60%
HB HAEMOGLOBIN

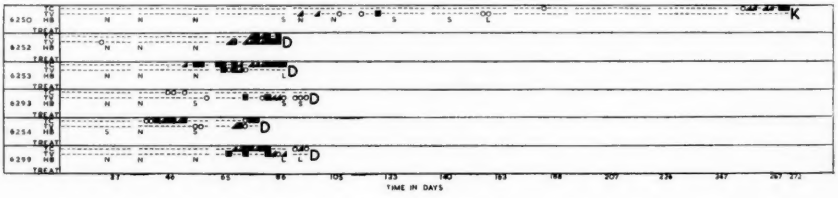
*(Article by R. N. T.-W.-Fiennes, page 473)*

CHART NO. 2 SHOWING RESULTS OF BLOOD AND GLAND SMEAR EXAMINATIONS ON DIMIDIUM TREATED CATTLE AT KIBOKO

GROUP 1 TREATED




GROUP 2 UNTREATED




| | | | |
|---|---|---|---|
| – | NO PARASITES SEEN IN 600 FIELDS OF A THICK SMEAR | ■ | HEAVY INFESTATION I.E. MORE THAN ONE PARASITE IN 2 FIELDS OF A THIN SMEAR |
| TC | T CONGOLENSE | ◢ | MODERATE INFESTATION I.E. MORE THAN 10 PARASITES IN 600 FIELDS OF A THIN SMEAR |
| TV | T VIVAX | O | LIGHT INFESTATION I.E. LESS THAN 10 PARASITES IN 600 FIELDS OF A THIN SMEAR |
| TREAT | TREATMENT | N | HAEMOGLOBIN 70% AND OVER |
| T | TRANSFERRED TO KABETE LABORATORY | S | HAEMOGLOBIN SUBNORMAL I.E. 60% TO 70% |
| D | DIED | L | HAEMOGLOBIN LOW I.E. BELOW 60% |
| K | KILLED | HB | HAEMOGLOBIN |
| ↑ | TREATED | | |

(*Article by R. N. T.-W.-Fiennes, page 473*)

XUM

Davey (1950) concluded that the best protection was given, as judged by blood smear examination, by 1.5 G. of antrycide dimethyl-sulphate plus 2.0 G. of antrycide dichloride. From the point of view of survival, however, best results were obtained by the use of 3.0 G. of the methyl-sulphate, for which only limited prophylactic properties are claimed.

**(3) Cattle Surviving at Kiboko on 30.9.49**

Results prior to 30.9.49 with surviving cattle have been given in another context by Fiennes (1950), but will be convenient to reproduce the analysis in Table II :—

TABLE II

*Showing the types and frequency of trypanosome infections in cattle, surviving at Kiboko on 30.9.49*

| | | | |
|---|---|---|---|
| A. | Never infected ... ... | 3/19 | |
| | Mixed infection ... ... | 4/19 | |
| | *T. congolense* only ... ... | 10/19 | |
| | *T. vivax* only ... ... | 2/19 | |

B. Numbers of Positive Diagnoses

| Nil | Once | Twice | Three times | Four times |
|---|---|---|---|---|
| Numbers of cattle | 3 | 5 | 4 | 4 | 3 |

These cattle had been treated with antrycide sulphate on each occasion on which a positive diagnosis for *T. congolense* was made from blood smears; no treatment was given for *T. vivax* infection. At this stage, that is, on 30.9.49, the surviving cattle were divided into two groups as under :—

*Group I* : Those in poor condition. These were treated with 1.0 G. of the methyl-sulphate on 30.9.49, followed by 2.0 G. of the dichloride on 30.10.49.

*Group II* : Those in good condition, which were not then re-treated.

Subsequently, no treatment was given unless the condition appeared to warrant it. 1.0 G. of the methyl-sulphate was then administered.

Histories of these two groups of cattle are shown in Chart I.

Thick blood smears were examined twice weekly and gland smears once weekly. In all smears, unless parasites were numerous, 600 fields were examined for trypanosomes using the 1/12 in. oil immersion objective. To avoid complication, it is not indicated in the chart, which results refer to the blood and which to the gland smears.

The results of treatment appear from the chart to be poor either because the parasites had developed drug-fastness or because of the refractoriness to treatment of the drug-suppressed type of disease. Treatment did, however, in some cases appear to improve condition and to prolong survival.

It is noteworthy that neither the clinical indications for treatment nor the eventuality of death appeared to be necessarily related to the level of blood infection. Deaths in some cases followed a usual pattern of recumbency, but

XUM

in others appear to have been due to syncope, the animal falling and dying whilst grazing. The animals, which were killed, were subjected to detailed autopsy and it is hoped to publish an account of this and of histological and parasitological findings at a later date.

The general history and the severe fall in the level of the hæmoglobin show that, with or without treatment, health was severely affected. It is not possible to say whether, in the course of time, any cattle would have survived with developed powers of resistance and restoration to health.

**The Histories of Cattle Protected by Monthly injections of Dimidium**

As a parallel to the cattle protected by antrycide, two groups were sent to Kibloko protected by dimidium. Group I received 10 c.c. of 3% dimidium bromide subcutaneously; this injection was renewed each month intramuscularly once trypanosomes had been found on blood smear examination. Group II received 10 c.c. of 3% dimidium bromide intramuscularly each month, whether or not infection was diagnosed. The cattle was sent to Kiboko on 25.1.49. Results up to 30.9.49 with Group I animals are shown in Table III and with Group II in Table IV:—

TABLE III

*Shows the results of prophylaxis in six cattle at Kiboko which received 10 c.c. of 3% dimidium bromide subcutaneously and thereafter 10 c.c. of 3% dimidium intramuscularly each month starting when infection had been diagnosed.*

| No. | Dates and Types of Trypanosome found Positive | Condition on 30.9.49 |
|---|---|---|
| 6250 | 22.4.49 TC & TV, 2.5.49 TC | Good |
| 6265 | 4.5.49 TC, 5.8.49 TV | Good |
| 6253 | 30.3.49 TC, 27.4.49 TC, 23.5.49 TC | Good |
| 6281 | 5.3.49 TV, 6.5.49 TC, 29.7.49 TV | Good |
| 6293 | 29.4.49 TC | Good |
| 6297 | 28.2.49 until 29.4.49 TC & TV, then negative | Good |

TC = *T. congolense.* TV = *T. vivax.*

TABLE IV

*Shows the results of prophylaxis in six cattle at Kiboko, which received 10 c.c. of 3% dimidium intramuscularly each month.*

| No. | Dates and Types of Trypanosome found Positive | Condition on 30.9.49 |
|---|---|---|
| 6258 | 23.5.49 TV | Good |
| 6266 | 27.4.49 TV, 3.6.49 TV | Good |
| 6276 | 27.4.49 TV, 30.5.49 TV | Good |
| 6280 | Never infected | Good |
| 6299 | 1.8.49 TV | Good |
| 6302 | 5.3.49 TV | Good |

TV = *T. vivax.*

It will be noted from results recorded in Table II that dimidium afforded apparent protection to the cattle in Group I for periods varying from one to just over three months. It will be seen that both groups, except for one animal in Group II, became infected with trypanosomiasis, but the cattle recorded in Table IV which received monthly injections from the start had never shown *T. congolense* infection up to the end of October and in two cases (vide Chart II) until December and February, which is ten and twelve months after exposure to tsetse flies. In spite of infection, both groups of animals were in good health and condition at this date and hæmoglobins were high in contrast to the antrycide groups. No losses had occurred. It was therefore decided to regroup the cattle—in one group treatment to be continued, in the second group treatment to be discontinued. Further histories of these animals are given in Chart II.

In the new Group I, No. 6280 became sick and was transferred to Kabete. It soon died, and post-mortem examination showed liver abscesses. The post-mortem findings did not appear to indicate death from trypanosomiasis. With the exception of this one animal the contrast between the two groups was striking. The new Group II animals had evidently not developed any great degree of resistance to trypanosomiasis at the time when treatment was discontinued. From this remark must be excepted the case of No. 6250—that is, one of the six animals—which developed a high degree of resistance and survived until the end of the experiment without further treatment and apparently in good condition. In Group I, the protection afforded by continued dimidium injections became gradually less effective. Though none of the animals died, *T. congolense* appeared in the blood smear and the hæmoglobin levels fell to 50%.

### The Development of Drug-Fastness Against Antrycide at Kiboko

Two new groups of thirty cattle, each protected by antrycide dichloride, were sent to Kiboko on 6.10.49 and 18.10.49. In each case, the expected course of the experiment did not materialise because of the development of trypanosome infections at an early date. There was a general break-through of *T. vivax* in less than four weeks and of *T. congolense* in eight to ten weeks. Treatment with antrycide and dimidium was unsuccessful, and most of the cattle had died in less than three months.

Limited tests with both *T. vivax* and *T. congolense* showed the parasites to be resistant to antrycide and partially to dimidium.

### Discussion

Davey (1950) had made no attempt to give antrycide at sufficiently short intervals to forestall infection. Had antrycide been given at shorter intervals, it is possible that a sterile immunity might have resulted. Three points plainly emerge :—

(1) That the cattle under experiment were infected with trypanosomiasis, though blood and gland smears were often negative for long periods;

(2) That the infection was in some cases controllable but not curable by drug therapy; and

(3) That survival, in those animals which survived, was partially dependent on a developed resistance factor.

To summarise the evidence for the last point, we may mention :—

(1) The survival without treatment of ten out of twelve cattle transferred to Kabete, in spite of the late development of trypanosomiasis;

(2) The virulence of the trypanosomes when subinoculated from them;

(3) The diagnosis of infections in three animals many months after their removal from the " fly " area;

(4) The equal efficacy of the sulphate and dichloride in securing survival; and

(5) The prolonged survival of one out of six cattle protected with dimidium, after protective doses of the drug had been discontinued.

The work shows how long a time both *T. congolense* and *T. vivax* may be present in the body without revealing themselves in blood or gland smears. For this reason considerable caution must be exercised in making deductions as to the length of prophylaxis, where blood or gland smears are the sole criteria used. Furthermore, monthly dimidium injections had given apparent prophylaxis against *T. congolense* for as long as ten months, after which parasites appeared in the blood. This must cause some hesitation about the acceptance of early results in work of this kind.

Since the methods used in the antrycide experiments—that is, by re-treatment when infection was diagnosed—appeared to offer no solution to the problem of keeping cattle in contact with tsetse flies, the survivors were killed for purpose of autopsy.

## Summary

(1) Experiments are described in which antrycide and dimidium were used to protect cattle against trypanosomiasis, when exposed to tsetse flies in a heavily infested area.

(2) The majority of the cattle died of trypanosomiasis, but a proportion survived until killed after sixteen to twenty months, although health was impaired.

(3) The dimidium was given at regular intervals, but the antrycide only after infection was diagnosed and then solely on the ground of clinical condition.

## Acknowledgments

I wish to acknowledge with gratitude the assistance rendered in this work by my colleague, Mr. H. R. Binns, who supervised the experiments during my absence in the United Kingdom from March to September, 1949. I further wish to record my indebtedness to the able and conscientious work of my two

XUM

African assistants, Mr. Philip Kamoyo and Mr. Edward Ochieng, of the Kikuyu and Jaluo tribes respectively. They have cheerfully undertaken the ardous blood and gland smear examinations, without which this work could not have been successfully accomplished. Last but not least, I acknowledge my indebtedness to Mr. W. G. MacLeod, Senior Laboratory Assistant, who delineated Charts I and II.

REFERENCES

Davey, D. G. (1950): "Experiments with 'Antrycide' in the Sudan and East Africa," *Trans. R. Soc. Trop. Med. Hyg., 43,* 583.

Fiennes, R. N. T.-W.- (1950): "The Cattle Trypanosomiases—Cryptic Trypanosomiasis," *Ann. Trop. Med. Parasit., 44,* 222.

---

# APPLES AS A PIG FOOD

By O. V. GUNNING, D.V.M., F.R.C.V.S.

*Acle.*

WHEN the writer started feeding apples to pigs he was surprised at the various warnings he received, for there appears to be a conviction that they are an unsafe food for pigs. It was at first thought that this belief was confined to the particular district concerned. However, after reading a warning in an agricultural journal of apples being the cause of death of newly-born pigs after the sow had been running in an orchard where there were a number of Bramley windfalls, it would seem that the view is not confined to one part of the country.

Mentioning to a neighbour that a litter of sucking pigs were scouring, the immediate reply was: "Ah, apples!" On another occasion a very experienced and successful farmer, on learning that the in-pig gilts were receiving apples, remarked: "I should be very careful with the apples." Other reports were more alarming, where it was alleged extensive losses had actually occurred. In fact, the warnings were so numerous that one had the uncomfortable feeling that the neighbours were waiting for a pig to die in order that they could say: "I told you so!"

On the other hand, no literature has been encountered to substantiate this belief. Neither Lander nor Long makes mention of apples as being poisonous to livestock.

Davidson, in his book on pigs, states that ripe fruit of all kinds are readily eaten by pigs. They will also eat unripe and over-ripe fruit in considerable quantities . . . fruit provides palatability and succulence in the diet, and in moderation helps to maintain the lower gut in good condition. In too large quantities, and particularly in an unripe condition, fruit will cause colic and diarrhœa.

XUM

Watson, in his book on feeding, states that apart from feeding windfalls to pigs fresh apples are seldom fed, in spite of the fact that they are a useful food for poultry and pigs, which will eat as much as 30 lb. daily.

On the whole, however, in books immediately available to us there appears little written on apples as a food for pigs, and some standard works omit them altogether.

In addition, in personal records of 172 separate investigations into the cause of death in pigs, in only one case are apples mentioned as a suspected cause. In this case nine small stores had been suddenly fed apples and were scouring; four had died. But as the owner had noticed the pigs chilled on the day of purchase, a week earlier, diagnosis in this case is extremely inconclusive.

A small practical trial was as follows. Last autumn an orchard which had been planted in 1914, containing some 75 matured apple trees, mostly Bramleys and Newtons, was loaded with fruit for which there was no sale.

Three Essex gilts were purchased and placed in a small paddock adjoining the orchard. One was 10 weeks pregnant and the other two 5 weeks. They were given just one or two apples to start with, gradually increasing at each feed until they were receiving about 20 lb. a day. In addition they received a pound of meal fed dry morning and evening, which was also increased as pregnancy proceeded, together with the available grass on a worn-out and neglected pasture. The apples were strewn over the paddock twice daily during the good weather, and as a number of trees overhung the paddock for several weeks there were more apples available than the gilts could consume. During this period they developed a keen discrimination, selecting only the best. When it became too wet to graze the pasture, they were fed inside in troughs.

The best apples were hand-picked, but the majority were allowed to fall. They were then gathered and placed in a long clamp and protected from the frost. The windfalls kept surprisingly well until they were finished in early March. Fodder beet were then substituted, but a little later in the spring the remainder of the hand-picked apples, for which there was no sale, were readily consumed by the pigs.

The gilts were therefore almost continuously fed on apples from the end of August, when they were a few weeks pregnant, until they farrowed, and during the nursing period. In all, several tons of apples were consumed. The sucking pigs began to nibble at them when a few days old. The gilts farrowed normally and were excellent mothers. There was only one piglet fatality soon after birth, and the gilts all quickly became pregnant again.

It is now the second season, and pigs both small and large have been running in the orchard. Immediately they are let out, and before they start grazing, they all hunt around for the unripe fruit as if it is the greatest luxury.

The only ailments encountered have been occasional scour in piglets, occasional mastitis in the winter months, and some lameness. One gilt went

XUM

blind. All these conditions however, also have occurred on an apple-free diet. The blindness is believed to be due to a lethal factor.

It is realised that apples have no place in a fattening ration. At the same time, in years when they are unsaleable the pig can play a useful part in their utilisation, and it is a pity if the use of apples is restricted owing to an unwarranted superstition.

REFERENCES

Nicholson, J. A.: "Lander's Veterinary Toxicology." London: Baillière, Tindall & Cox.
Long, H. C.: "Plants Poisonous to Livestock." London: Cambridge University Press.
Davidson, H. R.: "The Production and Marketing of Pigs." London: Longmans Green & Co.
Watson, S. J.: "Feeding of Livestock." London: Nelson & Sons.

---

# THE SYMPATHETIC AND PARASYMPATHETIC NERVOUS SYSTEMS OF THE FOWL

## Notes on a Thesis Presented for the Degree of Doctor of Philosophy

By T. GRAHAME, F.R.C.V.S., F.R.S.E.
*Edinburgh*

MANY theses, once they have been examined and the award made, are filed away in the alcoves of the library, many never again to see the light of day. Much valuable work is buried in this way. It would be sensible and reasonable to expect all authors to make a summary of their work in order that their findings might be made known in the scientific press.

Here are some of the findings of Dr. T. M. Hsieh, National Veterinary College, Lanchow, China, in his thesis, "The Sympathetic and Parasympathetic Nervous Systems of the Fowl," presented for the degree of Doctor of Philosophy at Edinburgh University:—

(1) The sympathetic ganglia in the thoracic and anterior lumbo-sacral region fuse with spinal ganglia.

(2) Sympathetic rami communicates only appear in the post-lumbo-sacral and coccygeal regions.

(3) The interganglionic cord is single in the cervical and anterior lumbo-sacral regions, double elsewhere.

(4) The anterior cervical ganglion serves as a centre of connections with the cerebrospinal nerves.

(5) There is no otic ganglion.

(6) The nasal gland is innervated by branches from the ethmoidal ganglion, Harderian gland by the Vidian nerve, lacrimal gland by the internal maxillary

and trigeminal nerves, maxillary gland by the medial and lateral naso-palatine nerves, palatine glands by the posterior palatine nerve, spheno-pterygoid glands by the glosso-pharyngeal and the Vidian nerves, anterior submandibular glands by branches from the submandibular ganglia, the intermediate group and ventro-medial group of the posterior submandibular glands by the glosso-pharyngeal nerve also the lingual glands and the crico-arytenoid glands, the gland at the angle of the mouth and the dorso-lateral group of the posterior submandibular glands by ramus anguli oris of the trigeminal nerve.

(7) The ciliary ganglion has connections with the oculo-motor nerve, ophthalmic nerve and the Vidian nerve.

(8) The glosso-pharyngeal nerve gives off the pharyngeal and the lingual as collateral branches and the anterior laryngeal and descending œsophageal as terminal branches. The anterior laryngeal is a branch of the glosso-pharyngeal nerve and not from the vagus. The descending œsophageal branch is continuous with the recurrent nerve.

(9) The posterior laryngeal N. is a branch of the recurrent nerve and does not supply the larynx.

(10) The anterior cardiac branch of the left vagus forms the anterior cardiac and right coronary plexuses. The anterior cardiac branch of the right vagus forms the left coronary plexus. The posterior cardiac branches of both vagi form the posterior cardiac plexus. The middle cardiac branches of both vagi, the right anterior cardiac branch and sympathetic cardiac branches form the superior cardiac plexus.

(11) The sympathetic cardiac nerve gives branches to the anterior cardiac branch of the vagus, the pulmonary plexus, superior cardiac plexus and posterior cardiac plexus.

(12) The pulmonary plexus is formed by anterior, middle, and posterior pulmonary branches of vagus and sympathetic branches from the cardiac nerve.

(13) There is no accessory spinal nerve but the jugular ganglion extends backwards alongside the spinal cord to the level of the second cervical spinal nerve. Neuroblasts appear in this spinal part of the jugular ganglion in 4- to 4½-day embryos.

(14) The greater splanchnic nerves arise from the 2nd, 3rd, 4th and 5th thoracic ganglia and form the cœliac plexus.

(15) The lesser splanchnic nerves arise from the 5th, 6th and 7th thoracic, 1st and 2nd lumbo-sacral sympathetic ganglia and form the aortic plexus.

(16) The nerves which arise from the 8th to 12th or 6th to 12th lumbo-sacral sympathetic ganglia form the hypogastric plexus, posterior mesenteric plexus and the pelvic plexus.

(17) No vagal branches can be traced to the hepatic, splenic and pancreatico-duodenal plexuses.

(18) The adrenal, anterior mesenteric, anterior renal, middle renal, posterior renal and testicular (or ovarian) plexuses are subsidiary to the aortic plexus and have no direct communication with the vagus nerve.

(19) The gastric plexus supplies the gizzard and the glandular stomach.

XUM

(20) The cœliac ganglion of young birds receives branches from the vagus.

(21) The intestinal nerve of Remak is a ganglionated trunk and receives branches from the anterior mesenteric plexus, aortic plexus, posterior mesenteric plexus, hypogastric plexus and the pelvic splanchnic nerves.

(22) The cloacal plexus is formed by the pelvic splanchnic nerves with many ganglia interposed amongst the fibres.

(23) There is no ganglion impar.

---

## *ABSTRACT*

## OBSERVATIONS ON THE GENUS PROTEUS*

A fairly extensive review is made of recent references to this subject which are to be found in human and veterinary scientific literature. It is observed that the occurrence of the organism as a pathogen is controversial in some cases. There is evidence in the literature to indicate that in man the genus is responsible for a variety of conditions of which cystitis is perhaps the most common. As a cause an enteritis in man, the position of the organism is in doubt although a number of cases are on record where the ætiological significance seemed to be confirmed. In the United States there have recently been a number of contributions in the veterinary press, some incriminating the organism as a cause of enteritis in the dog and others denying this claim. There have also been a few reports of disease in poults due to this organism, and one case of mastitis in the cow has been reported.

Species identification was not usually carried out in this present investigation, but in a few instances when this was done with specimens from chicks and poults, the organism was found to be *P. mirabilis*.

A comparatively high percentage of specimens of fæces from apparently normal dogs were positive and this made an evaluation of the importance of the organism as a cause of enteritis difficult. It has however been reported elsewhere that its occurrence in the stools of normal puppies is low and that at this age it may play an important ætiological role. Even in older animals when there is no other apparent cause of the enteritis, there is some evidence to indicate that its presence is of some importance. At least the organism may be an important contributing factor to the enteritis. This information was of value in determining the type of treatment to be adopted in some cases of persistent diarrhœa encountered in the Small Animal Clinic.

The incidence in the intestinal tract of normal chicks was found to be low and at least one other author has reported that it cannot be considered a normal part of the intestinal flora of chicks. A number of outbreaks of disease in chicks and poults are described in which other causes were not apparent and in which

*Abstract of thesis entitled "Observations on the Genus Proteus," presented in part fulfilment of the requirements for the degree of D.M.V. of the University of Zurich by Prof. Frank H. Manley, Department of Bacteriology, Alabama Polytechnic Institute, Auburn, Alabama.

the organism was isolated. In some cases a considerable mortality occurred. In a number of cases the organism was the only one isolated from reactors and suspicious reactors to the pullorum test, and the possibility of cross agglutination being a factor in some cases should be considered.

Examinations of rectal specimens were made from cattle and swine of various ages and the incidence was found to be comparatively low. More than half of the positive samples from swine were from one herd which was fed on raw garbage and housed under insanitary conditions. These points would no doubt have a bearing on the nature of the intestinal flora.

During the investigation the occurrence of Salmonella and related genera was recorded. Of over a hundred fæcal samples from dogs only one selected organism proved to be a Salmonella and that *S. schottmuelleri* (S. paratyphi B) which is reported to be uncommon in animals. A paracolon, confirmed as one of the Arizona group, was also isolated from a dog. Apparantly this group had not been reported previously from the dog.

The pathogenicity of *P. mirabilis* for young chicks and poults by different routes of injection was shown. The comparative effect of various antibiotics on Proteus was demonstrated *in vitro*. It was also shown that neomycin had a decidedly favourable effect on the course of the disease in young chicks artificially infected. This antibiotic was also found to be of value in certain persistent enteric conditions of dogs in some of which Proteus seemed to be involved.

---

## *REVIEWS*

NITROFURAZONE IN POULTRY RATIONS. Gordon, R. F., Chubb, L. G., and Stacey, C. G. (1953): Vet. Rec., *65*, 575.

THE authors review the literature on sulpha drugs and nitrofurazone in the control of avian coccidiosis.

Although the efficacy of certain sulpha drugs is established, undesirable side effects may arise if medication is prolonged. When fed at lower concentrations there may be no evidence of toxic symptoms, but marked reduction in egg production and growth rate has been reported.

Nitrofurazone has been shown to be effective in preventing outbreaks of coccidiosis when fed continuously at 0.005 per cent in rations containing adequate riboflavin, and no effect on the growth rate was noted.

Experimental work was undertaken to provide information on the effect of feeding nitrofurazone from one-day old to 16 weeks at 0.011 per cent concentration. The mash was of the conventional type containing fish meal 10 per cent, skim milk 2½ per cent and riboflavin 3.4 mg./lb. Growth rates were observed by weighing the birds individually at intervals to 16 weeks when the nitrofurazone was discontinued. The subsequent performance of the birds was recorded.

XUM

Egg production of birds receiving nitrofurazone was 87.5 per cent compared with 88.3 per cent in the control group. Hatchability of all eggs set was 67 per cent against 75.6 per cent in the controls; of fertile eggs 85 per cent with 92.4 per cent in the controls.

The authors conclude that nitrofurazone at 0.011 per cent, which is twice the concentration recommended for continuous feeding to chicks, exerted no significant effect on the rate of body-weight gain when fed continuously for 16 weeks, or on subsequent egg production. Some reduction in hatchability occurred, although this is probably not significant.

R. H. M.

ADVANCES IN VETERINARY SCIENCE. Edited by C. A. Brandly and E. L. Jungherr. Volume 1. New York: Academic Press Inc., 1953. Pp. xi + 431. Price 9.00 dollars.

THE scope of veterinary science, together with the great expansion of study and research in the specialised fields, has produced a literature so comprehensive that no one can keep abreast of all advances. It is for this reason that the editors, with the advice of a panel of seven other veterinarians of international repute, plan to review the progress in the active fields of research pertinent to veterinary science. This is the first volume and all the contributors are from North America; it is hoped to obtain contributions from all continents in subsequent volumes and to maintain a broad but fluid front line of modern knowledge. The concept has an extended basis for there is an added appeal to the individual who is concerned directly with the welfare of mankind; it is pointed out in the preface that human welfare has, in the past, been jeopardised by starvation and pestilence among the animals providing man with food and motive power.

The contributors are drawn from veterinary schools, public health services, agricultural experimental stations, communicable disease centres and health organisations. The subjects dealt with range from "Animal diseases and Human Welfare" to infertility problems in cattle; articles on virus diseases, sulphonamides and antibiotics, bovine mastitis and swine diseases are included. The last chapter is written by J. H. Steele, of the U.S. Public Health Service, and the importance of veterinary public health upon the life and well-being of man is portrayed. Not only does he deal with some of the important zoonoses —those diseases which are transmissible from animals to man—but he shows how the expansion of the veterinary public health programme within the U.S. Public Health Service has been justified. To-day it includes participation in radiological health, industrial hygiene, Arctic disease research and international public health programmes. The impact of some zoonoses on the health and efficiency of mankind is obvious and it is unfortunate that the enlightened outlook of some who write in this volume is not shared by those in other countries. In the U.S.A. veterinary officers inspect food products of animal origin, they are consulted on those diseases which may contaminate such foods, they participate in medical research programmes and have been responsible

for observations of importance to man especially in his search for new and greater sources of food. Trichinosis and leptospirosis as well as hydatid disease are such vital problems and it is now known that these conditions occur in the wild animals in Alaska. Naturally occurring neoplasms in animals may provide excellent opportunities for a study which may yield results favourable for mankind and there are about 80 infections or diseases of domestic and wild vertebrates which are potential threats to the health of man. This is the field of veterinary public health and there is, in addition, the economic aspect; the annual loss from animal disease in U.S.A. is about 2,000,000,000 dollars.

The first chapter by K. F. Meyer is stimulating and deals with a selected number of those diseases of animals that constitute a threat to the health of the human population; some of the value of his contribution lies in the balanced presentation made upon the economic and public health importance of the zoonoses. The chapter upon virus diseases is clearly written by enthusiastic believers in the omnipotent rôle of viruses in the causation of diseases. Although the views expressed will not be acceptable in their entirety, the review is excellent and Baker and York accept viruses as a constant challenge to be in some measure understood through the careful application of research methods. It is surprising to find an inaccuracy about the discovery of penicillin; Fleming reported upon it many years before the authors in the chapter upon antibiotics give him credit for so doing. It is refreshing to find the attention that is being given to the enormous potential danger of Brucella-infected bulls used for artificial insemination purposes and to read of the dangers of the spread of Vibrio and Trichomonad infection by the same agency. Surely the infection of the udders of cows with hæmolytic streptococci of Lancefield's groups A and C are not so rare that the danger should be dismissed so cursorily The descriptions of the coliform bacteria and of *C. pyogenes* are inadequate in the light of some of the knowledge available concerning these bacteria whether as causes of mastitis or of other conditions. The description of the habitat of *Strept. agalactiæ* needs enlarging when viewed in the light of the results obtained by those British workers whose observations on the carrier rate and reservoir of this organism are of some significance. Some names are wrongly spelled and Andrewes as well as Sellers suffer from this error.

Notwithstanding these small points, the volume is a worthy one and it is hoped that more will follow and that the high standard achieved will be continued.

VETERINARY DERMATOLOGY. Frank Kräl, V.M.D., M.V.D., and Benjamin T. Novak, Ed.D. London: T. B. Lippincott Company. Price 80s.

OF all the troubles which can beset the animal body those which involve the skin occasion most difficulty as regards ætiology, diagnosis and treatment. Their variety and the diversity in manifestation is prodigious. Some are the result of a specific exciting cause but there are many others to which such a relatively simple explanation cannot be applied for they are in some way related to metabolic change in other parts of the body. The skin functions as a mirror

and changes in its appearance and texture often reflect or indicate lesions in other parts.

By and large our knowledge of the various affections of the skin does not compare favourably with that of other tissues and this statement applies also in the case of human medicine.

The recorded information on veterinary dermatology is extensive but it covers little of the ground and, moreover, it is scattered widely in our literature and is not available freely to the ordinary practitioner. This book on veterinary dermatology marks the first attempt to gather the knowledge already available within the pages of one cover. We welcome it and congratulate the authors on their effort.

The first three chapters deal with the anatomy of the skin, methods of examination and the causes and classification of skin disorders. This refreshes the memory of the reader, and fits him well to follow and appreciate the succeeding chapters in which the various lesions of the skin are dealt with in a systematic manner. The book is profusely illustrated, always a good thing in any treatise on the skin.

The lists of references at the end of each chapter will be very useful to those who wish to delve further.

The book is a handsome one and for this the publishers can be congratulated.

It should make an excellent addition to the Veterinary Surgeon's reference library and it will fill a space that has been vacant too long.

---

# *NEWS*

## New Products

INTRODUCING their new Seleen Suspension to the Veterinary profession, Abbott Laboratories, Ltd., claim highly successful results in 334 cases where this product has been tested (87 per cent complete cure, 11 per cent improvement, 2 per cent no change).

Seleen is a liquid preparation for use in treatment in dogs of non-specific dermatoses and including summer eczema, moist eczma and fungoid infections. It contains 1 per cent of selinium sulphide with detergent base and used with reasonable care in the protection of eyes and scrotum is certified harmless to the animal. No evidence of toxicity is reported. One treatment is stated to be sufficient for elimination of fleas and lice. Seleen is supplied in 16 oz. bottles. Literature is available on request from Messrs. Abbott Laboratories, Ltd., Perivale, Greenford, Middlesex.

EVANS MEDICAL SUPPLIES, LTD., Speke, Liverpool, 19, announce the introduction of "Penacrin," a new veterinary preparation of Penicillin Proflavine and Cetrimide Cream.

XUM

They state that where a veterinary surgeon wishes to combine penicillin, proflavine and quarternary ammonium antisepsis, Penacrin is suitable. The pack consists of a jar of cream base together with a tube of powder. When the contents are mixed together the resultant 30 g. of cream contains in each gramme :—

1,000 i.u. penicillin
0.001 g. proflavine hemisulphate
0.0025 g. cetrimide

It is claimed that the dispensed cream retains its potency for at least two weeks when kept in a cool place. A simple tear-off dispensing label is provided. Penacrin is, of course, only supplied by or on the prescription of a registered veterinary surgeon.

---

## ERRATA

Article by Fiennes in issues of July and August, 1953:—

Page 283, line 12 : Fiennes (1952 *a, b*), should read 1953 (*a, b*); line 16, Fiennes (1952 *b*), should read (1953 *b*).

Page 337, line 12 : Fiennes (1952 *d*), should read (1952 *b*).

Alterations to Author's References :—

Fiennes, R. N. T.-W.- (1950): "The Cattle Trypanosomiases—Cryptic Trypanosomiasis." *Ann. Trop, Med. Parasit, 44,* 222.

Fiennes, R. N. T.-W.- (1952 *a*): "The Cattle Trypanosomiases— A Cryptic Focus of Parasites in association with a Secondary Stage of Disease." *Brit. vet. J., 108,* 298.

Fiennes, R. N. T.-W.- (1952 *b*): "Antrycide and the Future of Trypanosomiasis of Cattle." *Vet. Rec., 64,* 243.

Fiennes, R. N. T.-W.- (1953 *a*): "The Cattle Trypanosomiases—Experiments on the Maintenance of Cattle in Tsetse-infested Country." *Brit. Vet. J.* (in press).

Fiennes, R. N. T.-W.- (1953 *b*): "The Results of Autopsies on Trypanosome infected Cattle." *Ibid.* (in press).

Fiennes, R. N. T.-W.-, Jones, E. R., and Laws, S. G. (1946): "The Course and Pathology of *Trypanosoma congolense* (Broden) Disease of Cattle." *J. comp. Path. 56,* 1.

---

## Publishers' Notices

THE BRITISH VETERINARY JOURNAL, with which is incorporated THE VETERINARY JOURNAL, is published monthly, and copy for advertisements should be in the hands of the advertisement manager not later than the 20th of the preceding month, if proof is required. Tel.: Temple Bar 3386.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

Annual Subscription, 40s. ($6.50 U.S.A. currency, post free.)